THE NATIONAL ELEMENTARY

Principal

Science for Today's Children

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THIRTY-SECOND YEARBOOK NUMBER

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THE NATIONAL ELEMENTARY PRINCIPAL
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Foreword

IN THIS age of air travel, television, nuclear physics, and frozen foods, a yearbook on science would seem especially timely and of great potential value to principals of elementary schools. During the past few decades no field of human endeavor has matched the progress that has been made in science; developments in no other area have had a greater effect on contemporary life in the United States. And because science is a relatively new subject in the elementary-school curriculum, what to teach in science and how to teach it present great challenges to those in positions of leadership.

The Department of Elementary School Principals and the Yearbook Committee do not endorse all the ideas and practices enumerated in the 61 articles comprising this book. The setting of standards and the development of policies are not, and never have been, purposes of the yearbook project. The book should be viewed by the reader as a wide sampling of experience and practice and as a medium thru which principals and school staffs exchange ideas and beliefs.

The Membership Directory, which has been a part of previous yearbooks, is not included in this volume. The Directory will be prepared and printed separately this year. As in the past, all members of the Department will receive a copy.

In recognizing a few of the many persons who assisted in the preparation of this volume during the past two years, the Committee first wishes to thank Robert W. Eaves, Executive Secretary of the DESP, for his wise counsel and guidance and Sam M. Lambert, Assistant Director, NEA Research Division, who was in charge of editing and production. The committee also appreciates the valuable editorial and technical assistance provided by Violet Argent of the NEA Publications Division and Barbara Mertz of the NEA Research Division. Erle Prior, a commercial artist in Washington, provided the drawings for introductory pages to chapters.

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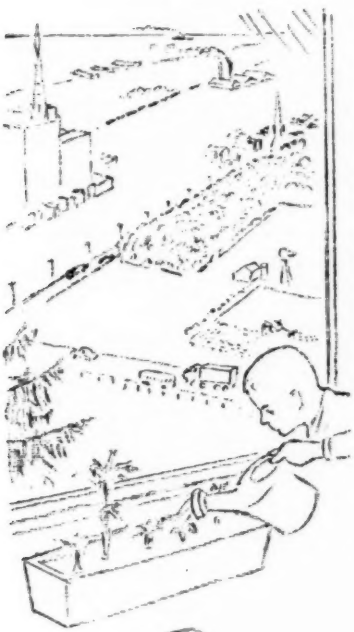
Frontispiece

The picture used as the frontispiece was provided by De Kalb County Schools, Lithonia, Georgia.

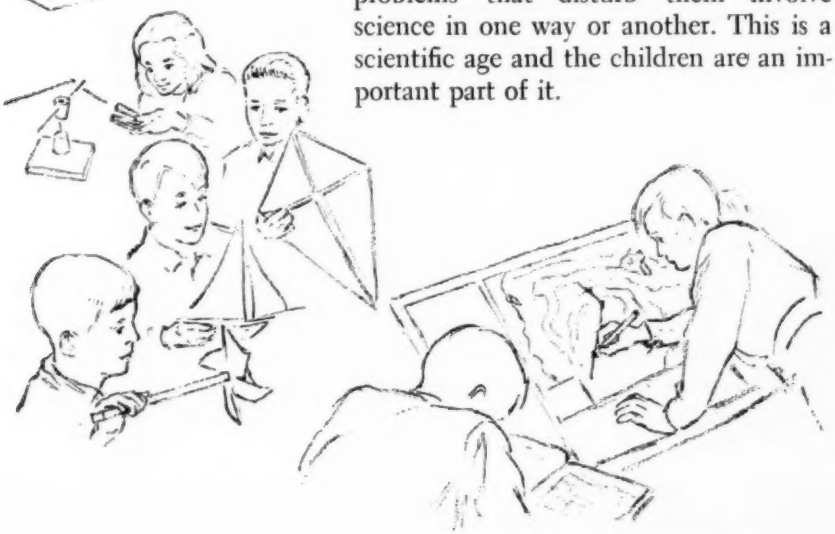
CHAPTER ONE

Elementary-School Science Today



KEYNOTING the yearbook for 1953, this first chapter sets forth basic understandings and agreements relative to the role that science should play in the program of today's elementary school. Here some of the recognized authorities on elementary-school science tell us what science can and should do for children; what aspects of science should be taught and how they should be taught; how science experiences contribute to child development.

There is no point in arguing for a strong position for science in today's elementary-school program; one only has to listen to the questions children ask their teachers from day to day to justify science in the curriculum. A great deal of what children think and talk about and many of the problems that disturb them involve science in one way or another. This is a scientific age and the children are an important part of it.



Science in the Elementary School

By GLENN O. BLOUGH
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MANY people believe children need science in school almost as much as elephants need water and geraniums need sun, and for about the same reasons—they can't really live, grow, and mature without it. Science influences in many ways the lives of today's girls and boys. The cars they ride in, the radios and television sets they use, the airplanes they see, the clothes they wear, and the foods they eat are all the results of application of the principles of science. The invention or creation of these things comes about thru diligent application of the scientific method of problem solving.

Investigations show that a large percent of the questions children ask—when they are free to ask them—are of a scientific nature, as are many of the things they bring to school to impress their classmates and teachers. Many of the areas commonly studied in the elementary school—social studies, health, geography, and so on—have scientific aspects. In school, at home, on Saturdays, and on vacations children cannot escape the influence of science or avoid seeing its manifestations. Anything, then, that is so much a part of the daily living of all of us deserves considerable attention when we plan the learning experiences of girls and boys.

WHAT CAN SCIENCE STUDY DO FOR CHILDREN?

In considering any single phase of a total school program, it is fitting first to consider what its potentialities are for making real contributions to the growth of children. We have stuffed more and more things into our school day until the hours bulge. Sometimes we have added without clearly understood reasons. We are, for example, quick to say, "Ours is a scientific age. No elementary-school curriculum is complete without science study." Agreed. But just what is this science study supposed to do for children? In what ways are they supposed to be different because they have studied it?

A Look at Science Itself

Science is sometimes described both as a method of work and as an organized body of subjectmatter. This description holds for elementary-

school science experiences as well as for any other science experiences. Just what does it mean in terms of the elementary school? It means that the method of discovery—the way we help pupils set up problems and solve them—is one phase of the science experience; what is discovered, checked for accuracy, organized into science facts and generalizations, and assimilated, is the other phase. The elementary school gives attention to both of these phases.

What is involved in the *method* of working in science? For years most of us have been familiar with the steps involved in the scientific method of problem solving.

In the elementary school we are certainly involved in problem solving, but we make no great fuss about the formal steps as such; we take them but do not concentrate on them as formal steps.

An excellent illustration is the following from a fifth-grade class studying the effects of air pressure. An experiment had been set up according to directions. Because of the pressure of the air, the gallon can being used in the experiment was supposed to collapse. Fortunately, it didn't. If it had, there would have been no problem solving. The teacher had set up the experiment to *show* the pupils what air pressure could do. But suddenly when the experiment didn't work there was a problem—a real one: Why didn't the experiment work? Fortunately, the teacher did not know why and was forced to let the pupils give their theories or their best guesses. She could not, herself, pick the correct one from the suggestions, so pupils had to try out their ideas and find the right one. When the can finally collapsed, they knew they had solved their problem. They had used a scientific method appropriate to their abilities. They had sensed the problem, put forth some theories, selected a likely one, tested it, and had drawn conclusions. Unexpectedly, the lesson had turned from one that would have involved only "looking on" and "listening to" to one that was scientific in its approach to solving a problem. Unintentionally, the teacher had taught a good science lesson.

Sometimes, then, teachers who do not know all the answers are the best problem-solving teachers, for, as in this example, they are then forced to let pupils help solve problems for themselves. This is not to say that the less science we know the better we teach. Rather it implies that it is not necessary for teachers to know all the answers before they can work successfully in a problem-solving situation with children. Some knowledge of science, considerable knowledge of how children learn, and the desire to see that they grow in ability to solve problems are some of the essential characteristics of successful science teaching in the elementary school.

Let us look briefly at the nature of the science problems appropriate for solving in the elementary school. Later discussions in the yearbook present many examples of these problems.

For one thing, it is important that the problems be meaningful to children. The answers should make a difference to the learners. The problems should be challenging but within the ability range of pupils. (We are sometimes inclined to make science in the elementary schools too difficult.) The problems may come from a variety of sources—from the children themselves, from classroom discussions, from textbooks and other printed material, or from local happenings. One example of such situations and problems is an epidemic of a communicable disease in the school which may create interest in problems about germs—what they are, how they spread, what they do in the body, and how the body reacts towards them. An eclipse of the sun or moon may bring out questions about the movements of the heavenly bodies, their nature, and the earth's place in the universe. A weekly newspaper may describe a new type of airplane and thus interest pupils in how airplanes fly and how they are controlled and improved. Many other illustrations of kinds and sources of problems will be found later in the yearbook.

Much more will be said about the nature of problem solving in the elementary school. It is sufficient here to point out that if we expect to develop ability to solve problems in a scientific way, we must be conscious of opportunities for solving problems and set up learning situations in which pupils will wish to solve problems. We must help them guide and evaluate the procedure. Above all, we must recognize that growth in problem solving is one of our goals and our actions must be governed accordingly.

Attitudes and Science Teaching

We also hope, thru experience with solving science problems, to help pupils grow in what we commonly call a scientific attitude; that is, pupils will jump to conclusions less frequently because of science experiences; will be much more likely to be open-minded, to hold conclusions tentative until there is convincing proof; will be more inclined to challenge sources of information, more likely to act intelligently on the basis of available evidence, less superstitious and prejudiced, and more observing and curious. This is indeed a big order of "attitude." Such a way of looking at things is not achieved by pupils overnight; it is not caught like the measles nor does it come about by living in the same room with scientific apparatus, science books, and mounted bird

specimens. How then? By living in a group whose teacher *intends* that all pupils will be conscious of the importance of the elements of a scientific attitude, in a classroom where there are countless occasions for using these elements, not only in science experiences but in all other problem-solving situations. Continuous emphasis on them thruout a pupil's school life can be expected to produce young people who are better equipped to solve problems in a truly scientific manner.

Here, indeed, is a place where there is much room for improvement. If we really intend to promote growth in scientific attitude, here are some things we must remember:

1. Pupils should not be permitted to generalize from small amounts of evidence. For example, pupils cannot decide that magnets will attract all things made of iron and steel simply because they have experimented with picking up an iron nail and a steel pen point. They can draw only limited conclusions from the simple experiments they perform. They must do other experiments, further reading, asking, and observing before they can be sure. This point of view applies to the many experiments we do at the elementary-school level.
2. Individual and group reports should be challenged often as to sources of information. "What makes you believe this is true?" Such questions should be asked frequently in science classes.
3. Children should learn to avoid drawing false and unwarranted conclusions from an experiment. All experiments should be carefully controlled and performed, and performed more than once, before they can give information on which we can rely. After careful experimenting has been done, it is usually necessary to consult reliable authorities for additional information and checking.

Many other examples could be given to show that a scientific attitude is essential to good problem solving. Using it is a definite part of the method of science. However, it is not gained automatically thru contact with the science course of study, but developed thru repeated use in meaningful situations in many different kinds of school and life experiences. Some of the experiences described later in the yearbook illustrate methods of working in science that are purposely intended to bring about growth and change in attitudes.

Scientific Knowledge

But should all the emphasis be placed on problem solving and scientific attitude? Do we not want our pupils to acquire some science information? Of course we do! Scientific information is part of the essential equipment of today's youth. Pupils need information in order to interpret the scientific phenomena which they observe every day.

It is scientific information they need to answer their many curious questions. Scientific knowledge forms the basis for their actions. It gives meaning to the rules of healthful and safe living. Pupils cannot think without subjectmatter to think with and about. It forms a basis for appreciation of the world in which they live, for the more they know about natural phenomena the more full of wonder they become.

We need, however, to re-examine the kind of information we expect pupils to assimilate. Too often we require young children to commit to memory such nonsense as the names of the structural parts of trilliums and katydids; or the definitions of little used scientific terms; or the names of insects, birds, and blossoms without learning anything about any of them. Perhaps such memorization, linked with learning unrelated and unapplied science facts, is responsible for the widespread shunning of science by many people, including elementary-school teachers.

To give significance to scientific information, the facts need to be gathered together into a generalization and applied to a meaningful situation. The generalization will be more limited in scope in the early grades; broader as pupils grow in ability to relate facts. Emphasis needs to be on information that makes a difference to boys and girls because it relates to real problems, on information that will help them interpret the everyday scientific phenomena that they see, and on information that will help them grow in appreciation of and interest in the physical and natural environment. This organized information that seems essential to a well-rounded scientific background comes from such areas as the living things on the earth, the earth and the universe, physical and chemical phenomena, conditions necessary to life, and how man strives to control his environment. It is from these areas that pupils gradually acquire the organized knowledge that constitutes their science background.

Interests and Appreciations

It is also from the experience of learning these things that we hope children will develop greater interest in and appreciation of the world of science in which they live. Their learning experiences should be so satisfying that they will retain the interest with which they came to school. The learnings should by all means broaden and deepen their interests and appreciation, and should so challenge the pupils with special interests and abilities that many will become career scientists and science teachers. Altho promoting science careers is not one of the major aims at the elementary-school level, it is, nevertheless, a consideration not to

be overlooked, for it frequently happens that life-long interests manifest themselves very early. Skilful science teaching at the elementary level —elsewhere also for that matter—should leave pupils wanting to know more and with the feeling of "I'm glad I know this and I enjoyed finding it out."

We have now considered some of the major purposes of teaching science in the elementary school. They have been written and said in countless places, but they need to be seen in action where pupils are working in science. Administrators, teachers, and pupils must be aware of them. They must color every action—the selection of problems, the way we plan and work, the way we evaluate. The content of Chapter Three, "Classroom Experiences in Science," may be judged by how effectively it may be used to accomplish the objectives.

WHAT KIND OF SCIENCE PROGRAM?

To achieve these objectives, what shall be the nature of the science program in the elementary school? First, it must not be regarded as a thing apart from the total living and learning program of the school. It is an essential part of it, for the objectives we have just discussed are essential to the development of good citizens in a democracy—a fundamental purpose of the school program. A good citizen must possess the ability to solve problems of living, must possess attitudes and appreciations that equip him to live cooperatively with his neighbors, must possess information essential to solving problems, and be familiar with and be able to use the skills to communicate his information and attitudes to others.

The good science program, then, is one that relates itself to the achieving of the goals of the total elementary-school program. It must, as a consequence, deal with problems of concern to children and provide opportunity for the use of a wide variety of tools of learning. The content of such a program is illustrated in many places thruout the yearbook.

Methodology in Science

There is scarcely a gnat's difference between good science teaching and good teaching of any other subject in the elementary school. The sooner more classroom teachers and others interested in science in the elementary school come to believe this, the better. In science teaching we consider first the child—his abilities, needs, interests, and other characteristics. Next we decide on what science is expected to do for him. Then we apply what we know about how children learn in setting

Gates Lane School, Worcester, Massachusetts

The children discovered that it was easier to pull the books up the incline than to lift them straight up.

up worthwhile problems and in solving them. Lest we appear to oversimplify, an examination of the following problems shows that they are not simple, but neither are they peculiar to science teaching.

The big problem seems to be that of helping classroom teachers develop background in science subjectmatter and confidence to teach—a problem that elementary-school principals are helping to solve in the preparation of this yearbook and in the development of inservice opportunities such as those described in a later chapter.

Even tho science teaching is similar in most respects to teaching in other areas, it is a new experience for many teachers and consequently has its problems. Should it, for example, be taught as a separate subject or in conjunction with social studies? Related to this are: How can teachers find time for science in an already crowded schedule? By what methods shall science be taught? How much use should be made of the textbook? What experiences and experiments are appropriate for elementary-school children? These are typical problems. Many of them will be dealt with in detail later in the yearbook. The real answers must come from each school as principal and teachers work together in local situations. The answers in every case depend on our objectives or intentions. A periodic re-examination of them is essential.

To illustrate: in some cases the objectives can best be realized when science and social studies are fused. The areas are mutually helpful

when, for example, pupils are learning how to make their community a healthful place in which to live. Here the science concepts of water purification and sewage disposal are essential to understanding some of the health problems of the community. To consider only the social problems is to leave out part of the essential story. On the other hand, a study of the vast field of astronomy provides opportunity to do real problem solving, satisfy curiosity, exercise elements of scientific attitude, and use the tools of gathering information quite independent of any other subjectmatter area.

It is important to point out that firsthand experiences, direct observations, and learning by experimenting are essential to good teaching and thus to a realization of our intentions. This means there must be "learning by doing" and "trips to see" whenever possible. It also means that these experiences need to be supplemented by the intelligent use of motion pictures, slide films, and other visual aids that help bring meaning to scientific concepts. These need to be expanded and enriched by the use of textbooks, encyclopedias, and supplementary books and materials. Firsthand experiences and visual materials can go only part way toward attaining our objectives. Books are an essential learning aid to achieving them.

Our objectives cannot be realized thru a "now-you-see-it-and-now-you-don't" science program. While incidental science teaching is sometimes very effective, incidents, children's casual questions, and the stuff they lug to school cannot be depended upon to provide a well-rounded science program any more than similar things can constitute a good social studies program. The program needs to be planned to allow for incidental learnings that are important, as well as for planned experiences that build a good program. Children's experiences may constitute the "stuff" of the program, but they need to be organized, developed, and added to in order to be truly effective. Later chapters deal more specifically with this problem. How we shall proceed to teach science, then, depends on how seriously we regard the purposes which we set up as guideposts for the program.

Evaluation of the Program

Much still remains to be done about evaluation in all fields of the elementary school, and science is no exception. When we think in terms of our objectives, we see that a series of true-false questions and a few "fill-in's" and short-answer questions will by no means measure our successes and failures. What then?

We need effective ways to measure understandings, for one thing.

Since it is not the minute details of information we are anxious for pupils to retain, we need some way to measure how well pupils put these facts together and assimilate the resulting understandings. Also, because we are anxious that pupils *use* this information to interpret the world they live in and to solve scientific problems, we need in some way to evaluate the *power of children to use* their information.

And this is but the beginning. Suppose our pupils are able to define "evaporation," differentiate between stars and planets, know the cause of the change of seasons, but still have not grown in ability to evaluate sources of information, still habitually jump to conclusions and are biased in opinion—have they "passed" their science? Have we "failed" in our teaching? More attention needs to be given to ways of detecting growth in scientific attitude as pupils grow and develop. And suppose pupils can identify mountain laurel, know that birds are helpful to man, and that fire cannot burn without oxygen, but still gather bunches of rare wild flowers, disturb birds' nests, and do not bother to put out camp fires—have they successfully participated in the science experiences in our schools? We need ways to evaluate with greater accuracy how effectively pupils act on the basis of their knowledge—how much we influence behavior thru instruction. We also need more effective ways to measure growth in problem solving and growth in interest and appreciation for the wonders of the scientific world. Later in this yearbook there will be a discussion of evaluative practices.

In connection with the implementation of this book, it is conceivable that committees of teachers and principals will spend some time working on the problems of evaluation and produce some technics that will be of help in determining more accurately how much our science instruction influences behavior.

WHAT IS THE PLACE OF THE PRINCIPAL?

This leads to the conclusion that how effectively this yearbook can influence practice in science teaching depends largely on the will, the way, and the willingness of elementary-school principals. Principals who believe that science is an essential element in the experience of children will help their teachers see that this is true; will find ways to work with teachers to give them confidence to explore science problems with children; will be willing for their teachers to say to children, "I don't know, but let's find out"; will help them find materials and other resources to adjust programs to fit the needs of science instruction; and will permit their teachers to go to see skilful science teaching if there is some handy.

Role of Science in Child Development

By HERMAN SCHNEIDER
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and NINA SCHNEIDER
Author and Editor

IN PLANNING a science curriculum for elementary-school children we need to consider two major trends. By now one of these is almost a truism—that scientific advances are causing, and will continue to cause, many alterations in the patterns of our daily living. The children we teach today may in the future use means of transportation, communication, and technology that we have not even begun to imagine.

Another trend, according to sober statisticians, points to an increasing rate of mental breakdown. Unless the trend is checked, they tell us, five or six of the children in any average classroom are likely to spend some part of their lives in a mental institution. The other children, needless to say, will not remain unmarked by the pressures that overwhelmed their more vulnerable classmates.

AGE OF SCIENCE OR ANXIETY?

Are these two trends causally related? Is the "age of science" inevitably accompanied by the "age of anxiety"? We have no ready answer, but as educators planning a science curriculum we need to explore the question. Has the scientific age that gave us jet transportation, antibiotics, television, and hydrogen bombs also contributed toward a greater and greater incidence of human failure? If it has, how can science education help mitigate the effects?

We know that advances in science and technology have caused a profound change in the individual's relationship to society. Sociologists who have explored the subject fully tell us that in the change from a personal, rural economy to an impersonal, predominantly urban economy, the individual has lost a sense of significance and rootedness. In a rural community, the loaf of bread, the home, the clothing were satisfying group achievements. Each role and skill was visible, comprehensible, and within the child's direct experience. The core of life was interdependence within a small group.

In an urban economy the picture is different. Interdependence is not based on clear, personal, small-group relationships but on intangible, large-group economic arrangements. An intricate maze of processes

separates the producer and consumer. What child can understand the relationships between individuals working at nameless tasks with unknown skills on an automobile factory assembly line? The anonymous relationship to the things we make and use has converted us into little islands, unaware of the substructure that joins us.

We cannot turn back the clock, nor do we want to give up the benefits of the scientific age in a back-to-handicrafts movement. But we do have to face the fact that the time of direct relatedness to our sources is largely over. So also is the time of gradual, fairly predictable change that gave people time to adjust, to find their places.

Today's changes are swift. Our six-year-old Bobby may want to drive a locomotive when he grows up, but we cannot honestly promise him that there will be locomotives for him to drive. We cannot promise anything—not economic stability, nor predictable social structure, nor peace, nor even the assurance that we have a workable program for achieving these objectives.

It is evident to every thoughtful person that the scientific age has been marked with violent dislocations of our economy, with terrifying competition for raw materials and markets, with an increasing tempo of destructive warfare, with a pattern of instability that deeply affects us all. Is it, then, mere coincidence, in this whirling kaleidoscope of a world, that an increasing number of human beings fail to achieve a sense of place and capacity, and withdraw, thru maladjustment and breakdown, from a reality that has grown too painful? Coincidence or not, these are our children and this is our problem: how can we educate our children to meet life confidently and competently?

TWO WAYS SCIENCE CAN HELP

The answers need to come from every area of the curriculum. In the teaching of science, particularly, we have an excellent opportunity to contribute in two significant ways. One of these ways has been recognized and constructively explored. The other is as yet comparatively undeveloped.

A Framework of Concepts

We have all recognized the need for providing the child with those facts of science that help him make sense out of his physical world. Toward this end, we give him experiences that lead to an understanding of the processes by which his food, clothing, and shelter are achieved. Experimenting with plants, making paper and cloth, mixing cement,

visiting a pasteurization plant, observing the school heating system—these activities can help to peel away the layers of anonymity that surround us and separate us from our sources.

We also try to relate his experiences to every curriculum area. We give added meaning to a social studies unit on water supply thru a science study of the water cycle, and we fortify its conservation phases by experiments on erosion and soil water retention. Safety rules on the playground are shown to be logical and functional thru a study of friction and balance, and we hope that the concepts can be carried over into future situations. In numerous ways, we try to teach science as a framework of concepts on which the child can build and around which he can organize his future learnings.

Science for Wholesome Growth and Development

But we can do much more with science, in a way as yet unexplored. We can teach science in a way that helps allay anxiety and contributes to the wholesome growth and development of the child. Moreover, we can do it without converting our science program into a course in social studies and mental health, without minimizing the accepted facts and concepts of science. What we need is a point of view, an orientation that can bring the science curriculum into closer relationship with the child's growth and development. Thru what we teach and how we teach it, we can help the child meet with confidence a rather complex and unstable world. Let us see what science has to offer.

Learning to live with change—One important contribution that a science program can make is helping children achieve a sense of the dynamics of change. Nothing is fixed; the constant factor of our universe is change. Men, moths, and mountains are subject to it. Yet many of us never come to terms with change; it seems random, terrifying, and unpredictable. We waste too much of ourselves fighting change. Here is a place where science can help us. The more science we know, the more order and rhythm we discern in change. We find it in the endless travels of a drop of water—change of state, change of place—but always subject to reasonable and consistent laws of cause and effect. We see it in the wearing away of a mountain and in the metamorphosis of a butterfly. In science there is endless opportunity for observing and recording change. Growth records, seasonal changes, weather charts, bird migration records—all can highlight change as a welcome and dynamic part of our lives. Change in a raindrop, a leaf, a stone—change is the order of the universe. But it is an orderly and consistent change whose lawfulness becomes apparent as we explore.

Even tho we may never penetrate to the end, we can use our partially acquired knowledge. Magnets give us charted paths on the sea and thru the air, altho we do not fully understand magnetism. Machines move mountains, miles of cloth roll off weaving machines daily, altho our knowledge of the nature of energy is imperfect. We continue to explore, to push back chaos, secure that further exploration will always lead us to a deeper assurance of order in the universe. And if in our little piece of the universe, our classroom, we can consistently build a feeling-tone of reasoned inquiry toward change, then perhaps our children will be helped to live competently and happily in this age of science, this age of swift change.

Facts and feeling—We need to recognize the role of feeling in the presentation of facts. Thru the way we teach science, we can lead the child to extract from his experiences and observations a sense of security and reasonableness. In every curriculum, for example, we include a study of the solar system. We teach that the earth is a globe, revolving around the sun. This fundamental concept can move the child forward or push him back, and our point of view can determine the direction. We can present the facts in a way that highlights the sensational and morbid, a method popular in science fiction, television programs, advertising, and, alas, many classrooms. We can learn that the earth rotates and revolves thru dark, vast, unknown space at unbelievable speeds—"hurtles" is the favorite current verb. We discover that the sun's heat, fierce enough to evaporate solid steel in an instant, could blast us to fiery death or congeal us in graves of ice, by a comparatively slight deviation in temperature or distance. We are told that the earth is but a minute speck in the universe, and that we mortals are appallingly insignificant in geological time and astronomical space. How scientifically true—and how emotionally unsound!

It is equally true and teachable that the earth's turning, within its soft blanket of air, is steady and firm and sure, that it carries us smoothly into warm radiant sunlight and cool lovely starlight in the ceaseless rhythm of night and day. It is also true that the earth's rotation and revolution are so exquisitely precise that we can predict the exact moment when sunrise will illumine the peak of Mt. Everest a thousand years from today. All this is also scientifically valid, and, at the same time, emotionally reassuring.

We must evaluate our facts to accentuate a positive, warm, hopeful attitude. Our choice of facts and the matrix of feeling in which we present them can guide a child forward toward security or contribute "scientific validity" to reinforce childhood fears and fantasies.

Science is good—We must emphasize, too, that the overwhelming

proportion of scientific advances have been motivated by goodwill, by man's refusal to accept disease and poverty as inevitable. Scientists have overcome their fears and explored areas that were considered unknowable and demon-ridden. Their need to explore and discover good was greater than their fears. Most men of science were people who cared, who wanted people to live well. They were men of goodwill. They were not intellectual icebergs or manipulating demons of the comic-strip clichés. Children of today need to know that science is a subject that has social meaning.

Recognizing developmental levels—In building the science curriculum, we need to recognize and explore more fully children's developmental and experiential levels. We know, for example, that six-year-olds have a need for large-muscle activities and have difficulty with tasks that call for fine coordination and close seeing. We recognize these problems by choosing science activities that do not require closely controlled movements and precise visual discrimination.

But we also need to recognize the child's developmental levels in other aspects. At the age of six he is very much interested in his emerging self. This is a good time for us to provide him with opportunities to observe, discuss, and experiment with his five senses; to encourage him to sniff and listen, to feel textures and temperatures, to become aware of his surroundings and to report his sense impressions, to move toward a more confident use of himself.

This is the time, too, when the young child shares with the robins the problem of leaving home, and he can gain strength from learning that other animals also grow toward self-care and independence. His fear of the dark is lessened as he experiments with light and shadow, discovers their nature, and learns that he can manipulate and control them. Painful competitiveness is reduced as the child discovers how group problem solving has marked the great advances in scientific research. The 12-year-old boy's distress at being shorter than the girl in the seat next to him, and her equivalent alarm at being taller, can both be alleviated as they learn about normal human growth patterns. Thru the solid, tangible experiences of science, children can be helped to meet their crucial fears and needs.

A sense of place and capacity—Science can help a child achieve a sense of belonging. As he studies the natural world, he begins to see that altho the forms of life are exceedingly varied, the basic needs are similar, and that he shares these needs. All living things must eat to live and in one way or another must strive to obtain their food. Moles dig, foxes hunt, and father goes off to an office or factory—all to fulfil the same basic needs.

As he gains insight into the world of plant and animal life, a child discovers many patterns of deep interdependence and relationship. He finds the evidence everywhere—on a field trip to the park, in observing and tending an aquarium, in studying an ant community. The bird he feeds in winter and the toad he refrains from killing in the spring will both help to rid his garden of destructive insects in the summer. In these simple experiences in conservation he learns that his acts have significance, that he is part of the life of the world. With a growing sense of his own place and capacity, he is able to move outward into a growing respect for all of life.

An approach to the unknown—We see, then, that the body of science, its subjectmatter, can be organized and taught in a way that contributes to important goals in child development. The method of science, too, can serve him well. Out of his experiences in recognizing a problem and working out its solution, a child can develop a habit of reasonable approach to the unknown. He discovers that there are logical ways of working on a problem, alone or with a group. Thruout a good science program he has many experiences in stating a problem, probing, testing, failing, evaluating his failures, checking his successes, and maintaining an attitude of open-mindedness toward new factors that may alter his findings. From these experiences he derives a sense of confidence because he has achieved a measure of success. He has solved problems; he knows that he has the capacity and technics for solving others as they come along. His experiences add up to a feeling of reasonable optimism about exploring the world of science. We can hope, and there are justifications for hoping, that this feeling of reasonable optimism will give the child a measure of confidence in solving problems in other areas of living as well.

SUMMARY

Thru a good science program, we can help our children discover basic, inherent elements of rhythm and predictability, of cause-and-effect relationships, within a world of uncertainty and instability. In a shifting, changing social and economic structure, we can help children face life with reasonable optimism. We can help children grow and develop technics and outlooks for functioning in a world whose constant factor is change. We can reasonably hope that experiences with science can contribute significantly toward a child's growth as a well-adjusted, happy member of society.

A Point of View for Science

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IN DEVELOPING a course of study for science at the elementary-school level, it was felt that we first needed some guiding principles to minimize lost motion on the part of committee members. The following point of view was developed in 1950 to meet this need. Numerous modifications and refinements of value arose from committee suggestions and criticisms.[1] For emphasis and clarification the writers have expanded a few sections and added others.

SCIENCE IN THE ELEMENTARY-SCHOOL PROGRAM

The welfare of the American people is closely related to scientific achievement, but the average citizen has a pitifully meager scientific background. There are many reasons for this, not the least of which is the neglect of science in the public elementary schools of the nation.

There has been a tendency in the elementary schools to neglect the physical sciences in favor of nature study, the argument being that children are not ready for these fields until they are older or know more mathematics.

The elementary-school pupil needs a wealth of experience in the physical sciences in order to apply his later learnings in mathematics. Science readiness problems are similar to reading readiness problems, and the best solution is numerous and varied related experiences. These are best obtained early in life thru many associations with such things as:

balls
magnets
balloons
bicycles
stilts
wheels
model airplanes
batteries
toy motors
musical toys and instruments
houses under construction
toy gyroscopes
wrenches
lenses
ice
fire
hose
tops
tools
toy boats
skates
blocks

[1] The committee: The Third- and Fourth-Grade Social Studies Curriculum Committee, Bakersfield City Schools, 1950; the members: Mildred Guhl, Betty Bell, Visalia Pinoris, Ruth Tinkle, Viola Arnold, Marie Bernard, Julie Biaggi, Virginia Cox, Johanna Smellie, Mary Jane Tate, Mary Vore, Ruth Harding, Merideth Thomas, Erma Crandall, Edith Fox, Maude T. Manuel, Bernice Mayfield.

At present, too much of this learning is by chance in play, girls especially receiving a meager background. Actually, the physical sciences belong in the classroom in every grade, beginning with construction work and play with magnets in the kindergarten.

THE SCIENTIFIC ATTITUDE

It is unfortunate that the teaching of science has been overly assigned the duty of training children to think clearly or scientifically. We know from psychology that children do not easily transfer learning from one field to another. This means that if children are to acquire the art of sound thinking, they must receive this experience in every subject—in social studies, health, sports, morals, and arithmetic—and not just during the science periods. It is vital that a scientific attitude pervade all instruction in all subjects if we are to train thinking citizens who will be a credit to a democracy. Scientific thinking will transfer only slightly from the science lesson unless the teacher consciously carries this attitude into these other fields.

INDOCTRINATION AND KNOWLEDGE

Indoctrination as well as knowledge is needed in the science program. A child may know all the facts about conservation and still not practice conservation unless he learns to want to conserve.

A doctor may know how to stay healthy but may not practice this knowledge unless he, in his life, has learned to take pride in a healthy body. The fact that elementary-school science teaching requires indoctrination with worthy incentives, as well as knowledge, is generally overlooked.

VALUES

In the science program the classroom teacher should strive to correct unfounded psychological attitudes and guide children to sound thinking. Our lives are littered with evidence of our failure to use our scientific knowledge, with superstitions, and with harmful social customs. Examples of unsound psychological attitudes are:

Fear of harmless reptiles, spiders, mice
Fear of stickiness, sliminess, odors of putrefaction
Rejection of horse meat for human consumption
Fear of the dark
Fear of doctors

Science teachers should encourage children to question customs and attitudes which show evidence of unsound thinking and the lack of application of our scientific knowledge. Examples of such customs include wearing high heels, smoking to excess, drinking alcohol in excess, processing foods best eaten raw, and failing to use heat reflecting paints on dwellings.

Altho the nature study phases of the science program lead in recreational values, other elements of the science field offer great opportunities for hobbies and leisure-time activities—mechanical tinkering, radio astronomy, home shops, and photography.

Many scientists are among our most religious men. The complexity of the universe forces one to the viewpoint that this life is more than happenstance. Creation and a Creator are essential to the scientist's philosophy.

Science is also changing our moral concepts. Just as better transportation is changing our ideas of what "neighbor" means, our rapidly diminishing resources are forcing us to rewrite the Golden Rule: *Do unto your descendants as you would have had your ancestors do unto you.*

SCIENCE, A "CATCH-ALL"

Elementary-school science has become a "catch-all," encompassing nature study, health, recreation, and conservation, as well as areas more correctly labeled. In preparing the science program, the classroom teacher may look upon such an imposing list of studies with some discouragement. It is recommended, therefore, that in planning what to teach in science, the teacher should be guided less by subject areas and the content of science books and more by the natural interests of the children in themselves and in the things around them. Science activities should answer questions and satisfy needs of the children themselves. Such should be the first requirement in evaluating a science program.

INTEGRATION

No school subject offers more opportunities for integration than science, except, perhaps, the language arts. Science can be related to history thru industrial development, transportation, and medical achievement; to geography thru maps, agriculture, industry, and geology. The scientific methods of problem solving are needed in all phases of the social studies. Science should be the backbone of health studies.

Science relates to physical education thru mechanics, ballistics, and physiology. Science relates to art thru color and space. It relates to music thru sound, construction of musical instruments, and concepts of time. Science is an ideal stimulant for reference-type reading and for oral and written language work. It can contribute to arithmetic readiness by encouraging children to measure, weigh, count, compare, and clock.

SCIENCE UNITS

The "unit" in science has to remain flexible as to allotted time and depth of treatment. It may last five minutes and be impromptu, such as a class observation of a hailstorm. It may take the entire year and still not be intensive, a study of the weather being a good example. It may be intensive and of limited duration, displacing for a time certain social studies work. A study of magnetism and its applications in the community illustrates such a unit.

The children became curious about all kinds of seeds.

Margery A. Rice School, Holden, Massachusetts

LACK OF BACKGROUND NOT A HANDICAP

Many teachers who attack without qualms a topic new to them, such as "Our South American Neighbors," hesitate to start a science unit because they lack background in this subject. Actually, the facts of science needed by a teacher in the elementary grades are no more difficult to learn than the facts needed to study South America and other commonly taught social studies units. The tools of the elementary-school science teacher are more likely to be soil, fruit jars, and needles than test tubes, spectroscopes, and complex chemicals.

Lack of background in science is not necessarily a handicap to a good classroom teacher. Most of the value in a science program comes from "exploring together" rather than from one-way, "teacher-to-pupil" learning. The spirit of science teaching should be "How can *we* find out?" and "Let's find out together." The best way to start teaching science is to *start*.

APPROACHES TO CURRICULUM DEVELOPMENT

Two approaches to the development of an elementary science curriculum are in vogue. The first is to develop a "spiral" curriculum in science independent of the social studies. This is the approach that arises from the laudable attempts of textbook writers and publishing houses to develop a logical growing sequence of science experiences from grade to grade.

The greatest weakness of this approach lies in the divorcing of science from the social studies. Since most science facts are important to the child only in terms of their social significance, this independent treatment of science is bound to fail in some degree to meet child needs.

Theoretically sounder, the second approach is one of correlation with the social studies. A curriculum developed from this point of view brings in science experiences as they relate to existing social studies units. Social significance is emphasized. The greatest weakness of this approach lies in the fragmentary nature of basic science learnings.

In practice, a combination of the two outlooks is needed. All desirable science learning that logically can be correlated with social studies may be so included in the social studies curriculum. The gaps in needed science experiences then may be filled in by developing additional science units at appropriate grade levels. In these additional science units, a special effort must be made to bring out the social implications of science learning so that science experiences will have real meaning and significance to the child. In the elementary school, there is no place for "science for science's sake."

Nine Reasons Why

By HANOR A. WEBB
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TO SUMMARIZE Chapter One, the students in my classes at George Peabody College for Teachers have helped me select and phrase nine *good* reasons for teaching science in the modern elementary school.

Science is taught in today's elementary schools:

1. *To give practice in simple observations*—as background for future investigation and understanding of the environment
2. *To give practice in purposeful activity*—as background for future experimentation and constructive labor
3. *To give experience in combining the factual and the emotional* (as caring for a well-loved pet or flower)—as background for future appreciation of natural law and beauty
4. *To enlarge the vocabulary with the names of simple objects and processes*—as background for the future use of necessary technical terms
5. *To guide emotional responses away from the highly subjective and toward the objective*—as background for future sensible attitudes and desirable behavior
6. *To start habits of scientific thinking in simple matters*—as background for scientific thinking in important future decisions
7. *To start building attitudes toward the simple social effects of science*—as background for future cooperation in community programs of health and welfare
8. *To develop simple concepts such as cause and effect, balance of nature, cycles of nature, and the like*—as background for future understanding of broad concepts like conservation of resources, the laws of learning, and even the sacredness of truth
9. *To develop a simple reverence for nature*—as background for future appreciation of the wisdom and power of God.

Hast thou named all the birds without a gun;
Loved the wood-rose and left it on its stalk?

—RALPH WALDO EMERSON, *Forbearance.*

CHAPTER TWO

Leadership in Science

PRINCIPALS, general supervisors, and special science supervisors are the leaders in elementary-school science, and the quality and effectiveness of the program will depend largely upon their interest, enthusiasm, vision, and willingness to help the classroom teacher. Gaining a personal understanding of the values of the science program in child growth; helping classroom teachers to learn on their own and from one another, and to gain confidence in their own abilities; knowing about and aiding teachers to use effectively the resources of the community; supplying the needed classroom materials and equipment; suggesting and advising on curriculum construction; and making time schedules flexible to allow for field trips and experiments—all are avenues to effective leadership in elementary-school science. Opportunities for leadership in science are both numerous and varied.

Ideas for the Administrator

By ELIZABETH HONE
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IN THIS great age of science many elementary schools are still ignoring the rich opportunity science offers for primary education. Children should be learning firsthand of the world in which they live instead of merely reading about it. As a youngster once said to a teacher, "Oh boy, are you going to teach us science? In our room we just read about it." A little moral and material support from a school principal can make a great difference to a classroom teacher who is willing to work in the relatively unfamiliar area of elementary-school science. Here are some ideas for the administrator who is willing to lend a hand.

SURVEYING AND USING SCHOOL RESOURCES

From the superintendent or school district office secure data on the training and experience of new incoming teachers. Some may have a rich background in science.

At the time of your first building meeting, introduce the new teacher who has a science background and enlist staff support for centralizing science equipment and materials with this teacher. Often valuable material is left unused for lack of such centralization of responsibility.

Take the new teachers on a tour of the building or delegate this responsibility to one of the experienced teachers. The science-minded teacher will make a mental note of available equipment and materials which will save many hours of hunting around on the outside. One teacher improvised a science corner for displays and experiments. Not until her second year did she discover in the basement of the building a bookcase suitable for a room museum of children's exhibits. A work table was also found which was suitable for electrical equipment and experiments with electricity in which the class was then much interested. Another teacher had searched neighboring libraries and written letters to publishers and book dealers for certain out-of-print references which she eventually discovered in the bottom of a seldom opened storage closet.

Many principals have permitted teachers to exchange class groups for the teaching of special subjects. In other words, Mrs. Brown, who has special ability in music, takes Miss Kane's group for rhythms, while Miss Kane, who is especially interested in science, takes Mrs. Brown's

children for science education. Let us suppose that some teachers are particularly skilful in playground supervision. Other teachers on the staff might care to set up the following special-interest program during the noon hour:

In order to allow individual children to draw upon special help wherever it resided within the school, the teachers regularly returned to their classrooms at a quarter of one. For the next half hour they were available on appointment for consultation. To facilitate this process each took the responsibility of planning with his own children so that they went to the expert with questions clearly phrased. Except for emergencies, when the appointment time might be cancelled, classroom activities in each room during this noon period were individual or small group activities that needed a minimum of direct leadership. This meant that the teacher could work with children from other classes without interruptions. A schedule, blocked off into fifteen-minute intervals, was posted on the bulletin board outside each room for children to sign. This period served individuals and small groups almost entirely. When a whole class needed a longer period of help teachers often exchanged classes.[1]

SCIENCE MATERIALS

Many times a single copy of a valuable science book or pamphlet is sent to a school but never reaches the science-minded teacher. Perhaps the school clerk could be instructed to pass such material directly to the interested teacher. He or she, in turn, would have the responsibility of circulating such material to the rest of the staff.

Perhaps the staff would like to have the science-inclined teacher start a science file for the building and even a science closet for equipment available to all classes. This, of course, implies joint contribution in return for use.

There are other possibilities such as assigning one science bulletin board arrangement or display during the year where the whole school can see it. Inservice training classes for teachers sometimes start a "swap club" among the members which facilitates the exchange of materials useful in science. Could not the same idea be launched within a school staff?

School administrators can increase the use of audio-visual materials related to science by the simple process of making them easily available. For example, in one school district, the audio-visual supervisor borrowed stuffed birds, mammals, and reptiles, and mineral and shell collections from a local museum and circulated them among her schools on a two-week loan basis. The hours of leg work so saved for the teachers enable them to do more effective teaching.

[1] Stratemeyer, Florence B.; Forkner, Hamden L.; McKim, Margaret G. *Developing a Curriculum for Modern Living.* New York: Teachers College, Columbia University, 1947. p. 445-46.

COMMUNITY RESOURCES

Principals usually have considerable knowledge of the parents and of the school community. This can save the new teacher much fumbling around in locating people who, by interest or occupation, can answer children's questions in various areas of science. For instance, one teacher never "reached" one difficult youngster until by chance she discovered that the child's father was an electrician, and enlisted the father's help in the construction of an "electric question board" for the class. As a result of Parent Conference Week another child brought to school an expertly made ant observation nest which she and her father had made for their own amusement.

Skunk Kittens and Silkworms!

Following chance leads, one classroom teacher discovered an old couple in the community who raised silkworms for a hobby, and who for several seasons endowed the classrooms in the whole school with a supply of silkworms. Then there was the family who the teacher heard raised pet skunks. She discovered they had a variety of pets and a wealth of knowledge about them gleaned from experience rather than books. The daughter electrified the class by bringing skunk kittens to school.

Conservation Groups

Because of teacher membership in a community conservation group, some members volunteered to go into the local schools on Audubon's birthday with colored slides and stuffed birds. At present this same group is working with the local school administration to found a school camp for the city in an area where the organization has conducted many field trips. The implications here for school-community interaction are unlimited in scope and value.

An Inventory of Places To Visit

With reference to interesting community locales for field trips, the principal often has a fund of information, and many districts have already compiled a list of places worth visiting. If this has not been done, it might be a valuable project for a school staff to compile a card file with data recorded on some standard form. The following items might be on the sample form.

A GUIDE FOR FIELD TRIPS

1. Name of place
2. Location
3. Address
4. Arrangements
5. Telephone
6. Of interest to . . .
7. Time of visit
8. Hours open

9. Length of visit
10. Number admitted
11. Facilities available
12. Description of trip
13. Time en route
14. Route taken
15. Things to see on way
16. Suggestions [2]

The Custodian Was an Expert

Since "the eye sees only what it knows," classroom teachers often overlook science resources near at hand. One teacher discovered the school custodian knew the trees and shrubs on the school grounds and, with the principal's consent, secured a little tutoring on the subject. Out of due regard for the custodian's rigid schedule for cleaning, the teacher and the children made a special effort to lighten the custodian's work in their room thereafter. The art supervisor contributed a lesson or two on drawing trees and very soon the foundations of a real Arbor Day program began to emerge.

FACILITIES AND EQUIPMENT

Principals without science training could not be expected to realize what a difference a sunny classroom makes in a science program. Raising plants, making blueprints, measuring shadows, and keeping pets are only a few of the things that depend on room exposure. A sink is eminently desirable and eliminates a lot of traffic down the hall to the lavatory to wash equipment or fetch water. An electric hot plate on a metal or asbestos pad is safer and as effective a heat source as a gas burner. A window box for plants, or at least window glass and adhesive tape for a terrarium, implement an attractive setting for science. A sand table has multiple uses, of which many are allied with social studies. A small bookshelf in the corner with a children's encyclopedia and some basic references encourages independent reading. A larger bookshelf for children's exhibits makes a fine museum and leaves the table free for experiments and other activities.

REWARDS

Elementary-school principals are busy people, but they always manage to take on more problems. When industry says it cannot get enough scientists to fill its needs, does it not behoove us as elementary-school principals and teachers to do something about it? Then when the next crop of Einsteins and Oppenheimers emerges from the elementary schools, we can take pride in having had a hand in it.

[2] Courtesy Montebello Unified Schools, Montebello, California.

Role of the Science Consultant

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LACK of self-confidence of classroom teachers is probably the greatest handicap that an elementary-school science program can have. This is not because elementary-school teachers know no science—they have lived with science phenomena all their lives—but because they are apt to think of science in terms of the formal and often meaningless courses they took in high school and college, and because they have had little help in interpreting the commonplace science experiences that should make up an elementary-school science program.

The most serious problem facing the visiting consultant is to find some way of reducing or eliminating this sense of inadequacy. He has other problems, of course, like organizing the program, showing classroom teachers how to present science materials, being certain that books and supplies are available, and making sure that teachers and pupils gain satisfaction from what they are doing, but these are comparatively easy problems to solve.

The writer has served as a visiting consultant in three school systems —a small city, a large village, and a central school. He has also directed several inservice workshops in other communities both large and small. He has faced this problem again and again. The remainder of this article summarizes the procedures he found most effective.

THE WORKSHOP APPROACH

The most successful technic the writer has discovered for introducing a science program is the workshop, with the term "workshop" meaning exactly that: a place where teachers can use tools and science materials. Indeed, the best place to conduct this workshop is the school shop itself.

Studying Things, Not Generalizations

From the very beginning little time is spent in this workshop on lengthy discussions of the values of teaching science or on the establishment of vague generalizations on which to base the program. Instead, the teachers are started off with things that they themselves can do in the classroom. They are shown how to make terrariums, how to stock and care for aquariums, how to experiment with magnifying glasses and growing plants, and how to make periscopes.

For many classroom teachers this is the first time that they themselves have had an opportunity to work with science materials, and they gain much satisfaction from the experience. This is also the first time many of them have studied "things" instead of generalizations, formulas, and principles; they are surprised that the subject can be so interesting.

Teachers react favorably to this type of approach. They leave each session with a number of practical suggestions for which they can see immediate application. By working with the materials themselves, they gain confidence in their ability to carry out suggestions and they realize that it is within their power to do effective science teaching.

The Cruder the Better

The writer has one technic which he believes helps greatly in developing teacher assurance. He purposely refrains from using any refinements in the projects that he demonstrates. His motto is, "The cruder the better as long as it works." A suggested house for second-graders to wire is but a cardboard carton on its side with wires leading thru two holes punched in the "ceiling." On seeing this crude house every teacher says to himself, "My pupils could do a better job than that." As a result he lets them try and they succeed, improvising with many novel and ingenious ideas. If the original demonstration had called for an elaborate house which needed special tools and technics in its construction, many teachers never would have felt competent enough to try.

The consultant may use in the workshop many of the same technics he would recommend for use in the classroom. For instance, in introducing simple electric circuits to a group of second-grade teachers, he may give them dry cells, wire, lamps, sockets, buzzers, and necessary tools. He may then suggest discovery technics by which they find out how to make lamps light and buzzers buzz. Thus, the teachers learn not only the actual ways of making circuits, but also some successful ways of dealing with circuits in the classroom.

Working Toward Broader Goals

In the same manner the consultant may show teachers how to work toward the broader goals of science education, setting a suitable example himself. To show how critical attitudes and skill in drawing conclusions may be developed, the writer likes to set up standard demonstrations. He may cover a burning candle with a glass jar and ask, "What does this prove?" At first the stock answers of high-school and college science courses come automatically, but soon the teachers begin to criticize each other's conclusions and to qualify their own. They then see how to handle similar situations in their own classrooms.

A Clearinghouse for Ideas

The workshop has another important function in helping classroom teachers gain assurance and satisfaction. It serves as a clearinghouse for the exchange of ideas and for the exhibition of pupil achievements. Some classroom teachers have more experience with science teaching than others, and the wise consultant lets them make their contributions. As soon as an activity program in science starts, both teachers and pupils begin to devise endless variations of the original suggestions. Everyone is stimulated by seeing what others have done.

THE CONSULTANT CONSULTS

The term "consultant" implies that the person to whom it applies holds himself available with advice and suggestions to whoever seeks his services. But many consultants are disappointed because so few teachers voluntarily come to them for help. The occasional teacher who is already doing some work in science comes, but the ones who need the most help seek the least. This is but natural; teachers who are teaching science have problems, the ones who are not have none. The consultant must find ways to make himself useful; just being available is not enough. He must find ways to go to the teachers and to get the teachers to come to him.

Ailing House Plants, Unhappy Goldfish

The workshops already described give classroom teachers and consultant something in common. If a teacher starts a winter garden which develops mold, she will be almost certain to call on the consultant for help. In fact, most of the calls for the consultant's services will be for things of this nature—ailing house plants and unhappy goldfish, electric motors that will not run, and periscopes that do not hold together. There are few requests for help with programs and lesson planning, no matter how much the consultant believes such help is needed.

The writer does not feel that the consultant should go to classroom teachers with suggestions of ways to improve individual programs. Too many teachers will interpret the offer as criticism of their work.

A Good Excuse for Visiting

The consultant will do well to have good excuses for uninvited visits to individual teachers. He may take science materials such as some new water insects or an unusual plant for the children to see. He may visit to stimulate interest in participating in science fairs, parents night exhibits, and the like. He may drop in to see something which he has heard about as being unusual. These excuses give the consultant an

opportunity to become personally acquainted with the teachers. Once classroom teachers know the consultant as a sincere, friendly person, they will be more apt to ask for help.

Science Consultant or Encyclopedia?

A few teachers like to make of the consultant an encyclopedia of science information to which they may turn for answers to pupils' questions. They may even go so far as to have pupils save up questions for several weeks, after which they invite the consultant in for a "free-for-all" with the children. Everyone concerned may have a good time at this meeting, but it is doubtful if any useful purpose is being served. The practice does not encourage pupils to find their own answers from direct observation or by reference to competent authority. Also it minimizes the stature of the teacher who usually feels incompetent enough already. The consultant might better work thru the teachers.

ORGANIZING A SCIENCE PROGRAM

The writer has preferred to take the responsibility for the initial science program. Too often he has seen teachers struggling with curriculum construction, dissipating initial energies and enthusiasm in this difficult assignment. To be properly fitted for building a science program, teachers should be well grounded in the basic science concepts, they should understand thoroly the goals of science education, they should have a wealth of teaching suggestions, and they should have considerable experience in teaching science to children. There are few elementary-school teachers who have all these qualifications.

It seems better that the consultant, who is supposed to have these qualifications, plan the course of study which he is to introduce. Usually the consultant is the only one who is capable of setting up a tentative program. He will, if competent, plan a program that is fun for pupils, that is easy for teachers to handle, and that meets the goals of science education by minimizing talk and textbook reading in favor of actual learning thru doing.

However, once a program has been initiated, teachers will begin to acquire the necessary background for curriculum construction. They will accumulate the technics and skills needed for teaching science and they will gain experience in using them. They will become more aware of science phenomena and they will begin to gain a factual background thru observation and reading. And if, by example and constant reference, the consultant has made the teachers aware of the desired outcomes of a science program, they will gain this last ingredient. Then the teachers are ready to build their own program; the work of the consultant is done.

Guides to Leadership

By FLORENCE E. LEARZAF
Principal, Horace Mann and John Morrow Schools
Pittsburgh, Pennsylvania

THE role of the elementary-school principal as an effective leader in the development and maintenance of a successful science program is a most important one. There are many ways in which the principal can assume his rightful place as the leader in this challenging area. These ways run the gamut from a subtle comment to the complete reorganization of a school schedule.

KNOWING OBJECTIVES AND TECHNICS

Before any educator can endorse and lead a program with enthusiasm, he must be convinced himself that the program is a good one. Therefore, the first thing he must do to prepare himself for his part is to become better acquainted with the aims and objectives of the elementary-school science program, as well as to understand the accepted procedures and technics used in reaching these goals.

Where a science program has been established, the principal will want to know and support the one advocated by the administration of his school system. Where he is the "pioneer," he will want to read various courses of studies, manuals from approved science textbooks, the textbooks themselves, and the publications of various professional organizations interested in public-school science.

ENOUGH TIME AND AN INTERESTED TEACHER

The area of elementary-school science must have prestige, respect, and consideration comparable with that of any other subject in the curriculum. Since the schedule determines the time allotted to the teaching of science in a departmental organization, the principal predetermines this when a new schedule is made. In this type of school organization, from three to five periods per week are desirable. The self-contained classroom must also provide adequate time for effective science teaching.

Since many people hesitate to undertake the teaching of science because of an admitted fear of living things or because of a lack of science training, careful consideration must be given to the member of the faculty who receives this assignment. When a choice can be made,

certainly any teacher who has a love of nature along with a personal enthusiasm for science teaching, plus a willingness to learn with the children, should be selected at once.

SHOWING INTEREST

From the beginning of the school year, the administrator must encourage the teacher to create a climate within the classroom that allows even the casual observer to know that "this is the science room." This encouragement may be given in many ways. Favorable comments and constructive criticism on attractive bulletin boards and sincere interest in units studied help any teacher to continue his efforts in the approved direction. The principal can further encourage the classroom teacher by clipping his own magazines for colorful pictures and interesting articles and by sending for free and inexpensive materials which may be used in the science room. After a week-end trip or an evening's work in the back yard, the principal may contribute a praying mantis, a few cattails, or some other interesting item for the specimen shelf.

As the year progresses, opportunities for visits to other schools should be planned so that the teacher may see various room arrangements and science projects, as well as meet successful teachers who will share the "know-how" they have gained from experience.

OBTAINING LITERATURE

To help the newly appointed teacher and the teacher who lacks training in science acquire confidence in the area of elementary-school science, several good reference books should be made available for constant use. In school systems where basic textbooks are supplied for children, it is the principal's responsibility to be certain that these books are on hand for classroom use. Since children need to have the points of view of several authors, a variety of other books should also be available for classroom reference work. In addition, arrangements should be made with the school librarian or with the local library for further opportunities for additional research on the units being studied. The principal may find it necessary to encourage the classroom teacher to call on the many resources of the library for assistance in daily lesson preparation and for help in the identification of specimens.

AUDIO-VISUAL AIDS

The use of audio-visual aids is essential in the effective teaching of elementary-school science. It will be necessary for the principal to help secure adequate projectors, record players, radios, and television sets. Guidance in the selection of educationally sound materials must be

given. Sufficient time on the schedule should be available for preteaching and postteaching activities.

HELPING WITH FIELD TRIPS

Field trips, too, are an integral part of any good science program. Once again, it is the principal's responsibility to keep the schedule flexible enough so that a double period or a half day for a trip may be arranged. A study of community resources should be made so the classroom teacher will know what services are available. The principal can help with the details of the first trip by sending home parental permission slips and by making arrangements for transportation when this is necessary. Again, time should be provided for necessary preteaching and postteaching. After a few trips go off smoothly, the teacher will no doubt wish to assume most of these responsibilities.

PROVIDING RESOURCE PEOPLE

Residents of many communities can be used as resource persons, and the principal should familiarize himself with the many ways these people can help in the science program. Among such persons may be a park naturalist, a member of a nature club, or someone actively engaged in scientific work. After an interview, the principal may wish to ask these people to visit the school to lead a discussion or to display pictures.

HELP FROM PROFESSIONAL SOURCES

In school systems where supervisors or consultants are available, the principal should take advantage of this important service. Where in-service meetings and workshops are offered, the principal should encourage his teachers to attend. Beyond encouragement, the principal can arrange to release the teacher to attend the meetings and, when possible, attend some of them himself. The teacher should be encouraged to join a professional organization of science teachers and to participate actively in local conferences and conventions.

TO KINDLE THE SPARK

To summarize, strong leadership in elementary-school science can be achieved by the principal knowing the program, showing a favorable attitude toward it, providing a workable schedule, securing adequate supplies, and lending his personal encouragement and endorsement. It is the responsibility of all principals to kindle the spark of enthusiasm for better work in the teaching of elementary-school science and then, as the years go by, to keep the flame burning brightly.

A Cooperative Venture in Sex Education

By A. KERMIT FRATER
Principal, Lowell School
Madison, Wisconsin

THIS is a report on how school and parents worked together on a project in sex education at Lowell School, Madison, Wisconsin. We do not claim that we have found all of the answers. Many communities can do better and we are quite certain that we can do better, too. Perhaps the only reason for telling the story is to report the plan—a plan that so far has made it possible to handle a controversial subject without controversy.

PUBLIC REACTION TO THE IDEA

Several years ago the film *Human Growth*,[1] produced by the University of Oregon, was made available in Madison. It was shown rather widely in PTA groups with considerable discussion on possible use. At that time there was no organized study in schools of human reproduction.

Over 300 parents returned questionnaires after seeing the film on sex. The results were as follows:

1. Do you think your children should see this film?

Yes	97.1%
No	2.9

2. At what age do you feel children might profit from seeing this film?

Below 10 years	15%
10-12 years	59
13-15 years	23
Above 15 years	3

Several parents remarked that children should study sex before adolescence—before getting emotional about the subject. The 59 percent who checked "10-12 years" as the proper age seemed to verify this opinion. Most teachers who attended these meetings, 92 percent, also checked the 10-12-year age interval.

The result seemed to indicate that the elementary schools were getting the nod to introduce some form of sex instruction at about the sixth-grade level, and we, at Lowell, took up the challenge.

[1] *Human Growth.* 16 mm, sound, color, 20 min. University of Oregon, Medical School, Portland 1, Oregon. 1948.

PLANNING

As a first step we took an inventory of our curriculum to see what we were already doing that would help lay the foundation for such a study. Discussions of the family, of pets, and of farm animals were a regular part of the kindergarten and primary experiences. Units on care of the body and on personal and community health were scattered thruout the grades in health and the social studies. At the sixth-grade level the reproduction of plants and simple animals was studied in the science room. In fact, much of the vocabulary needed for a study of human reproduction was being taught via flowers and the formation of seeds. Sixth-grade girls were learning about menstruation thru an animated cartoon and discussions with the physical education teacher and nurse. At the same time the boys in their physical education classes were learning about the changes they might expect in the next few years—changes in voice, size, and appearance.

This information was given to parents of sixth-graders when they were invited in to consider the problem. *Human Growth* was shown at this meeting and a discussion period followed. The health educator from the city board of health spoke briefly on the need for adequate sex education.

No final decision was made at this time on the use of the film, but some definite opinions were expressed:

1. Boys and girls should see the film at the same time.
2. There should be an opportunity for discussion and answering children's questions.

There was a difference of opinion, however, on who should do the job: 90 percent wanted the school to do it all, while 5 percent preferred to have the film shown in the evening so that parents and children could see it together. ("This would tend to break down the barrier between me and my boy. He just never asks questions about sex.") Another 5 percent did not want their children to see the picture at all. Most of the 90 percent who wanted the school to take over said they would bring their children to an evening showing if that was the only way for them to see it.

PROBLEMS

The decision was now up to the staff. Several problems were noted:

1. The board of education had passed a resolution requiring parental permission for children to be shown the film at school. Would it be a desirable situation to have some of the children excluded from it? Wouldn't they be unduly curious? Conceivably a parent could sign hurriedly without realizing what it was and later object with resulting publicity that could harm the whole movement.

2. Who would conduct the follow-up discussions? The science teacher who had taught reproduction of plants and simple animals was the logical person, but it was her first year out of college. Perhaps we were all a little reluctant to blaze the trail.

MAKING DEFINITE DECISIONS

We felt that the school definitely had a responsibility in teaching about sex, but that parents also have that responsibility; and if they were adequately prepared, they could do a good job. Parents would have the further advantage of being available to answer questions over a longer period of time while the child usually had new teachers every year or so. Perhaps the school could contribute most by teaching the background for study of human reproduction and then helping the parents to do the rest.

Thus, it was decided that:

1. We would invite parents to bring their boys and girls to see *Human Growth*.
2. It would be in the evening when there would be no immediate problem with children who were not permitted by their parents to see it.
3. We would request that parents and children sit together, hoping that it would tend to break down any barriers to later discussion.
4. We would make available to parents what literature we could obtain from the city and state boards of health that might be helpful in later discussions.
5. We could show the film two different evenings with an interval of a few days between. In this way people who could not come one time might be able to another. Also, some might wish to come back for a second showing.
6. These showings would be scheduled as soon as possible after the study of reproduction in the science classes.

STRENGTHS AND WEAKNESSES

Now after three years, with three successive sixth grades, we believe that this has been a worthwhile project and that the method is worth continuing. In each case we have preceded the above steps with a meeting of parents to go over the entire plan, to preview *Human Growth*, and to select literature that may be of help. An authority in the field of social hygiene is also invited to speak on the need for sex education.

There is one glaring fault in the procedure: not all the children get to see the film. The first year 56 percent saw it, the next year 75 percent, and then it dropped back to 63 percent. No doubt the indifference of some parents has kept their children away. We know that in at least some of these cases the parents honestly do not want their children to see it, and it was largely because of this that we decided on the eve-

Public Schools, Madison, Wisconsin

Studying plants and how they reproduce themselves is helpful in understanding human reproduction.

ning showings. On the other hand, the response has been far from discouraging. We average about 90 sixth-graders in our three sections. Each child in the approximately two-thirds who attended was accompanied by at least one parent. In several cases the parents also brought children of high-school and college age, making a fairly impressive total.

RESULTS

In order to get parent reaction we sent questionnaires to those who had brought their children in the evening. About two-thirds were returned. All agreed that it was "good for the child" to see the film and

that it helped them as parents. "There were things I didn't even know myself," reported some.

Six parents thought that it should have been shown during school time but the rest now thought evening was the best, with parents and children together. "It opens the road for discussion. We know just how much our child knows and this has made it so much easier to discuss after seeing it together. We are very pleased that we had the opportunity of seeing this film with our child, and we want our other children to see it *with us* when they are in the sixth grade."

All had a discussion with their children afterwards. A few reported that the children talked about it among themselves. A boy to his mother: "Bobby and William didn't get to see it and they wanted to know what it was all about, so we told them. We told it to them straight and they didn't snicker either." Perhaps the benefits extended into the streets!

Two mothers cited changes of attitude in their boys: "Norman is much more satisfied with the subject of sex than before, and far less curious. . . ." "Joe seems less nervous and much more at ease—I think the whole subject has been on his mind for some time."

Other comments: "Children should see it twice." "I think this helps a father explain things that he would otherwise let slip by." "I think it is a fine thing for the school to help in this way." "I really think that the work carried on in science had developed the children's curiosity to such a point that they were ready for the film. Without this they would not have been ready. In our case it so happened that the big question had arisen just three days before the showing of the film, so the timing was perfect. It confirmed my explanation and cleared up any vagueness that might have still lingered in his mind. I would like to take this opportunity of thanking you . . . for your helpful and progressive attitudes in education and modern living."

The questions that came up in the classroom, such as "What makes twins?" and "Why do kids look like their dads and moms?" were answered promptly and simply. Apparently the parents had done a good job because only a few questions were brought to school.

We feel that results warrant our continuing in about the same manner, with emphasis on getting the widest participation possible. Perhaps visual aids a little better suited to our purpose will be produced and thus make the study more effective.

The story ends here because our boys and girls leave Lowell to go to junior high schools, but the project goes on. Studies of family life and marriage continue to come at appropriate times as our young people mature.

Role of the Elementary-School Principal

By CARL H. KUMPF and
E. BEATRICE HEINEKEN

Principal and Science Teacher
Miller Street School
Newark, New Jersey

A GOOD elementary-school science program depends upon the principal's efforts to foster enthusiasm for the teaching of science. This enthusiasm should be felt by the pupils, the community, and especially the classroom teacher. Teacher enthusiasm can be promoted best when the principal has confidence in the teacher who teaches science.

HELPING THE CLASSROOM TEACHER

Assistance to the classroom teacher requires a well-rounded program of inservice education. Help in understanding the science curriculum with which the teacher must work is of prime importance. This understanding must include not only how the curriculum can help the teacher, but also how the teacher can go beyond it. A study of the curriculum guide may be carried on individually, thru staff meetings, by grade levels, by grade groups, or in committees.

An early goal of the science education program is the development of desirable attitudes: an understanding of the method of science, an understanding of the environment, an enjoyment and appreciation of the physical phenomena. Such attitudes as being open-minded, yet skeptical; being sensitively curious; differentiating between fact and fiction; understanding cause-and-effect relationships; seeking at all times the most reliable information; realizing accuracy is a direction; proving statements by experimentation; being free from superstition; and having a respect for the truth are basic to a good program in science. Scientific method should be understood as a way of planning and working—as withholding judgments until all the facts are in and regarding all judgments and conclusions as tentative and subject to revision.

Workshops, either schoolwide or systemwide, are of great help to teachers just beginning to teach and those with some experience who wish to improve their technics. Workshops are often offered by local colleges and universities, particularly during summer sessions. These, plus extension courses, give classroom teachers needed background for the teaching of science. Principals might discuss with teachers the merits of the various courses offered in order that the course chosen by the teacher best fits her needs in this field.

The alert principal will arrange staff meetings on science programmed for the year. One purpose of these meetings is to provide a wide range of rich and varied experience with physical and biological phenomena.

A procedure which often pays dividends is the scheduling of voluntary staff meetings on science. One to five classroom teachers at a time come in to work on their individual problems. A teacher comes to these meetings only as long as he feels that he is being helped. He comes when he feels a need, remains only as long as he thinks it necessary to meet this need, and returns when he needs further assistance.

Many school systems provide a science supervisor to assist the classroom teacher. Some large elementary schools have a science teacher for the upper grades. Such a science teacher can be given several service periods, spotted among his teaching periods, during which classroom teachers may consult with him on the teaching of science. The science teacher also can go to the classroom and assist the teacher in the development of science projects.

COOPERATIVE PLANNING

The principal can help classroom teachers, particularly when science instruction is new in the school, by encouraging teachers of the same grade to develop science units cooperatively. This procedure encourages the teacher who may feel a bit timid about teaching science. It gives each teacher the benefit of the good ideas of fellow teachers.

Plans developed cooperatively also tend to be more complete. Teachers are encouraged to talk over the outcomes of using the plans in order to gain the advantage of knowing how the unit developed in each class. Altho the same initial plan may be used by two or more teachers, the results will vary from class to class. Comparing notes on the results of instruction makes it possible to improve the plan before further use.

TEACHER PARTICIPATION

The principal can improve science teaching in his building by encouraging teachers to participate in activities which contribute to better classroom work in science. Among such activities are meetings of science teachers associations, meetings on conservation, and programs of the local museum of science.

At least one teacher in the building could be encouraged to make science an area of special interest. Such a plan not only provides the school with one exceptional teacher of science, but has the effect of raising the level of science teaching thruout the building.

Science materials can be easily and interestingly exhibited. A museum case in a strategic part of the school, where it can be seen by most chil-

dren and visitors to the school, stimulates pupil activity. One teacher had the pupils bring in products made by their fathers and mothers in their daily work. The class then investigated the part played by science in the development of these products.

PUPIL ACTIVITIES

The principal should be a source of ideas and suggestions for pupil activities in science. A good science teacher is familiar with many of the pupil activities which make for enthusiasm for science.

A science corner should be provided in each room for exhibiting materials brought in by pupils. A feature of such a corner could be a "What Is It?" section, a large box with two compartments. In one compartment is an item brought in the week before and investigated by interested members of the class. These investigators report their findings to the class and may write a short explanation to be posted over the item. In the other compartment appears a new item brought in during the current week for investigation.

Services of older children may be used by teachers in demonstrations and in cleaning equipment and aquariums, and sometimes they can be used as group leaders with smaller children. Needless to say, both teachers and pupil helpers make it a point to know their science materials before offering to help other classes.

The principal can suggest when classwork might lend itself to an assembly program on science. Surveys could be made in the community to discover how science principles are being used. Animal feeding stations could be set up. Pets could be brought into the classroom and the proper care of them could be demonstrated. Then there is a host of activities such as science trips, making scrapbooks, keeping notebooks on data connected with a special interest, making models, taking snapshots, showing motion pictures, and making collections.

RADIO AND TELEVISION

Teachers today may draw upon many sources for enriching their teaching. Among these are radio and TV programs devoted to various phases of science.

Some school systems, such as Newark, New Jersey, have their own radio outlets, while others, such as Rochester, New York, are given blocks of time by commercial stations for school broadcasts. In either case the teacher is provided with direct aids in the teaching of science as well as other subjects. Participation of teachers in planning and staging these programs is a tremendous stimulus to better science teaching. Children participating in these programs profit greatly.

It is a responsibility of the principal to take the steps necessary to provide classroom teachers with needed receiving sets for radio and television. As the number of teachers who regularly use programs increases, there will be a tendency to improve the programs concerned.

A number of science programs of a desirable nature are being broadcast during out-of-school hours. Teachers can be encouraged to refer their pupils to these programs and to utilize the information contained in the programs in the development of classroom science lessons.

PROFESSIONAL BOOKS AND MAGAZINES

It is the duty of every principal to supply and encourage the effective use of professional books and magazines. Fortunately, there is a wealth of material available on the teaching of science in the elementary school. From time to time considerable space is devoted to various aspects of science teaching in professional magazines. Good textbooks and supplementary books at elementary-school reading levels are appearing more and more frequently.

One copy of each of the better written professional books, along with many of the magazines and journals containing science articles, should be available in each elementary school. If possible, each classroom teacher should have at least one professional science book of his own. Teachers who develop interesting and effective technics and show originality in their teaching of science should be encouraged to write these experiences and submit them to professional magazines.

EQUIPMENT AND MATERIALS

The principal can aid his school in the development of a science program by providing the necessary science equipment and by giving help in the use of it. Classroom teachers must have easy access to this equipment if they are to use it freely. As a start, a box of minimum special equipment can be provided for the school and moved from room to room as needed. Next, there can be some duplication of frequently needed items which may be kept in individual classrooms.

Some opportunity should be provided for experimentation with homemade equipment. Much of the interest in science and the learning thru science emanate from the development of equipment using common items found almost anywhere. The use of homemade equipment makes the study of a particular problem more meaningful and effective.

Films, filmstrips, slides, and pictures dealing with the various units in the science program should be collected and made available to all teachers. In the larger school systems a large central library of these

items together with an up-to-date catalog in each school would suffice. Where this plan is used, it is important that the persons in charge of the library be apprised of the needs of teachers as these develop. Coupled with these aids in teaching science is the matter of providing adequate projection equipment. The American Council on Education has compiled a list of minimum equipment of this type which should prove helpful to the principal.[1]

The value of the local museum of science should not be overlooked in considering sources of available equipment. Many school systems have worked out a loan plan with a nearby museum. Children may be encouraged to use museum facilities in after-school hours as a means of checking facts learned in science lessons and as a source of new interests which find their way into classwork.

It is wise for each individual school to develop a list of experiments, field trips, and other science experiences feasible for the local school. In this way no opportunity to enrich the science program will be overlooked.

EVALUATION

It is essential that the staff continually evaluate its science program if the program is to become effective. To do this efficiently, it is desirable to establish satisfactory criteria for evaluation.

A cooperatively constructed checklist on science should be used for its beneficial effect on teachers. The construction of the checklist points up in the teacher's mind the goals of the science program. It serves as a reminder to the teacher of what is important in science teaching.

FOUR WAYS TO HELP

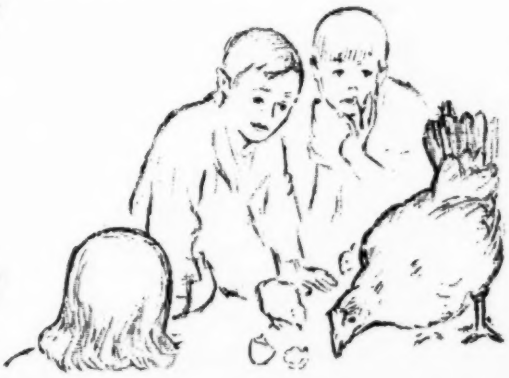
This article has been written to show that the principal can do much to encourage science instruction in his school. Classroom teachers can be helped (a) to see that science is of interest to children, (b) to become familiar with the science curriculum, (c) to handle the subject-matter of science with ease, and (d) to use freely the equipment and supplies needed to carry on an adequate program.

[1] Seaton, Helen Hardt. *A Measure for Audio-Visual Programs in Schools.* Series II, Motion Pictures in Education, No. 8. Washington, D. C.: American Council on Education, October 1944. p. 36.

CHAPTER THREE

Classroom Experiences in Science

SHOULD farmers kill blackbirds? Do stones grow? How do rockets work? What causes earthquakes? Do people live on the moon? Such are the problems that originate in the minds of children which skilful classroom teachers, as described in this chapter, can develop into lively yet practical learning situations. This chapter is devoted to a series of descriptions of interesting, exciting, and, in many cases, unusual classroom experiences. Unlike Chapter Four which sets forth long-range projects which cover large areas of science, this chapter consists of short articles relating to things that can be done in a single class meeting or in a few short lessons. In each case only easy-to-obtain materials and a limited knowledge of science are required. The subjectmatter of this chapter ranges all the way from egg-hatching projects to imaginary trips to faraway worlds.



Setting Hens and Buzzing Bees

By KATE BELL
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Staff Writer for the Houston Post
and ROBERT B. OVERSTREET
Staff Writer for the Houston Press

ELEMENTARY-SCHOOL science classes are a constant source of excitement for children in the Houston public schools. So many interesting things are going on that even the newspapers find many good stories in the things that happen from day to day.

This article describes two events which are typical of the types of learning experiences in science provided for our elementary-school children. Because the *Houston Post* and the *Houston Press* reported such interesting and lively accounts, we are letting the newspapers tell most of both stories in their own way.

HATCHING CHICKENS

From the question, "How do chickens get out of the eggs?" an experience of setting a hen and waiting for the eggs to hatch was started. Other questions were soon raised: Where do eggs come from? How do they get out of the hen? How does the chicken get into the egg? How long will it take an egg to hatch? How warm is it under a hen? What kind of food do chickens eat?

To find answers to these questions, we read books and poultry magazines. A chicken rancher visited our class and talked to us about raising chickens; the county agricultural agent served as a resource person. But best of all, we set a hen and waited until the chickens hatched.

Experience chart lessons which we named "Our Nest of Hopes" were written during the time we had our chickens. A color film was made and we appeared on a television program sponsored by the Houston school system. The *Houston Post* reported the following story on April 6, 1952.

TEACHER AMAZED—
PUPILS TAKE POULTRY BIOLOGY LESSON CALMLY

On March 11, Mrs. Troy Reynolds, a motherly, brown-eyed teacher of one of the orthopedic classes at the Lantrip Elementary School, watched her young pupils place one fertile egg under Mrs. Elaine.

Mrs. Elaine is a charcoal-colored hen with a comb as red as Rudolph's nose and a disposition suitable to associating with children. She came to the classrooms to give the pupils a graphic science lesson—to be spe-

cific, a lesson on how eggs are hatched.

For days before her arrival, the pupils prepared a home for her. They took a small barrel and cut it into two pieces and used one of the halves as a nest. They put soft straw in the nest and placed it in a large chicken coop.

Mrs. Elaine arrived in a setting mood. From the beginning, she exhibited a motherly attitude toward the 15 white eggs. When the room thermometer was pushed under her so the pupils could find out "how warm it is under a setting hen," she ignored the alien object.

After Mrs. Elaine was set, the students marked the date, March 11, on their calendar. They read that it takes 21 days for chickens to hatch, so they also marked March 31 as the big day for the blessed event.

The pupils never doubted that Mrs. Elaine would bring off the job on time, although their teacher found herself staring doubtfully at Mrs. Elaine from time to time.

During the long wait, the pupils kept a diary. They dictated the words and spelled them out. Mrs. Reynolds wrote them in a big book. As the time for the blessed event drew near, the class was asked to appear on a television show.

The pupils were very eager to help inform the television public about their three classes. Mrs. Reynolds teaches the middle-sized children; Mrs. Lucille Cavell, the younger children; and Mrs. Mary Kelly, the older children.

Mrs. Reynolds' youngsters even promised the television people that they would have some chicks on March 31. They asked Hanson Senteney, the public school photographer, to come to their school on that date and take some pictures for their television show. . . .

But on the eve of March 31, Mrs. Reynolds became nervous. The next day she showed up for class with a bundle of baby chicks under her arm. She bought them at a hatchery, but she needn't have done so.

About 10 a.m. on the appointed day, one of the pupils heard a peep. A yellow, cottony ball soon stuck its head out from under its mama's black wing. Its 10 brothers and sisters came popcorn fashion. It was exactly what the book said would happen. The elated pupils were not surprised. But Mrs. Reynolds stared in wonderment.[1]

EXPERIENCE CHARTS

The following experience charts were made into a booklet by the school secretary so that each member of the class could take the lessons home to read to his parents.

1. We hope to have chickens for Easter

We want to hatch our own chickens.

We had trouble finding a hen. Not many people in the city keep hens We asked our bus drivers. We asked everybody we knew.

We thought about putting an ad in the paper. When we were about ready to give up, Joanne said, "I have a hen."

[1] **Middlebrook, Ellen. "Teacher Amazed—Pupils Take Poultry Biology Lesson Calmly."** ***Houston Post,*** **April 6, 1952.**

We had to be sure that Joanne's hen wanted to "set." That means that she will stick to the nest until the eggs hatch. She will leave the nest only to get food and water.

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2. Getting the home ready

Of course, our hen had to have a quiet place to set. Our room is very crowded. We have seven tables in our room. . . . We have to have room for our wheel chairs. There are 11 desks for us and one for the teacher.

Our old box was worn out. New lumber costs too much, so Mr. Reynolds made a home for our hen. Mr. Scott came at night to open . . . the door to let him bring the house in.

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3. We set our hen

Here's where we get stumped. We had no room for the hen's house on the floor, so we put it on a table.

The girls made a soft nest with yellow straw. Charles and Jimmy cleaned the windows. Larry and Roy washed the floor.

Tony and Ben put the eggs in the nest and put the hen on top of them.

We put 15 eggs under our hen.

Our hen's name is Mrs. Elaine, because that is Joanne's mother's name.

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4. Caring for the hen

Hens like corn and other grain. We had some corn and maize that Roy brought for our seed study.

Gloria will keep water in the hen's house. Charles will look after the food. Tony will clean the house. Roy and Jimmy will clean the windows.

When we get our chickens, we will *really* have a job.

We will ask Mr. Scott to care for them on the week ends.

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5. How long will it take?

We must wait three weeks for our eggs to hatch. We set our eggs on March 11, 1952.

They will "come off" on March 31, 1952. That will be 21 days.

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6. Our big fright

One afternoon we were listening to a story. All was very quiet when all of a sudden the noise began. Mrs. Elaine got off her nest with a jump and a jerk. She looked up through the top and said, "Cack-cack . . . cack-cack!!"

Nobody said a word. We looked at each other. Suddenly Mrs. Kelly and her boys and girls appeared at our door. They said, "What has happened?"

We said, "We do not know."

Someone said, "She must have looked at Larry!"

Mrs. Elaine soon quieted down and went back to work. Then we caught our breath again. Maybe we *will* have chickens for Easter.

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7. Caring for baby chicks

Little chicks need baby chick food.
We must buy some mash.
We need a water bottle that will let out a little water at a time, so the little chicks will not get themselves wet.

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8. We learn about "setting" hens

We let Mrs. Elaine starve for several days! She would not leave her nest because she was afraid her eggs would get cold.

We could not miss any of the food that we put in her house. One day we had a visitor. She put the bowl of corn up to the hen's mouth, and what do you think!! She ate 27 grains without stopping. She drank a lot of water, too.

Now we know much more about hens—setting hens, that is.

Now we keep the food and water up high near her mouth so that she will not have to leave the nest.

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9. Our chicken family

"Peep, peep"—"cluck, cluck"; that's what we heard on March 31, 1952. When we got to school, we had four wet, wobbly chickens out of their shells.

We watched one of our chickens break through the shell.

We listened while he pecked his way through the shell.

When the second day was over, we had 12 little chicks. There were six black ones, five yellow ones, and one Rhode Island Red.

CAPTURING HONEY BEES

The second unusual opportunity for a valuable learning experience in science occurred quite unexpectedly. The *Houston Press* published a lively account of the event.

BEES BUZZ . . . BUT THEY DON'T SCARE CHILDREN

There's not much you can tell 1300 Condit Elementary School children about the bees, now.

Not after what happened Thursday.

At 11 a.m. a huge swarm of honey bees—very smart ones, the children insist, because they know in just what grade to start school—clustered under the eaves of the temporary building which houses the first grade.

As it happened, the bees might have done better to swarm closer to the fourth grade, where the boys and girls keep an observation hive and are especially friendly with such creatures of nature.

But no one was inconvenienced, much less frightened.

No one made a dash to call the fire department—the usual treatment accorded stray bees in Harris County.

No Sir!

Mrs. Velma Edwards marched her fourth-graders outside for a closer look and to see about chances of adding the swarm to their collection.

But while they were figuring how, word of the attraction spread to the

school librarian, Mrs. L. A. M. Barnette, who is on even more familiar terms with the "apis mellifica."

She donned blue jeans, threw a veil over her head, and started to work with the help of a stepladder.

By this time the principal, Miss Ellen Stearns, decided there was more of an education to be gleaned in the schoolyard than from indoor reading.

"We brought out all the children and moved them in by classes for a closer look as Mrs. Barnette made trip after trip between the eaves and the hive with frames full of bees," Miss Stearns said.

"At times the bees were crawling over her hands and arms, showing the children that bees won't sting if you don't frighten them."

Not a child was stung.

"We've had a magic show and trick dogs so far this year, but I think the children feel this was by far the best show." [2]

IT'S NO LONGER AGAINST THE RULE

Mrs. L. A. M. Barnette, librarian, who contributes her service to the school, was asked if transferring the bees was not hard work. She laughed and said, "Perhaps so, but it's lots of fun, too. I must write another verse for the children." These are the verses she wrote and dedicated to the children of Condit School.

Today if Mary's little lamb
Should follow her to school,
The teacher wouldn't turn him out.
It's not against the rule.

Instead she'd bring him in the room
And call the children near.
Each child would get to feel his wool,
Might even learn to shear.

What children bring to school these days,
Is anything they find.
You'd really think that Mother Goose
Was not so far behind.

Yes, fish and snakes and tadpoles too,
As well as birds and squirrels
Are going to our schools today
Along with boys and girls.

They bring in shells and stamps and rocks.
They study ants and bees.
They learn of health, which food to eat,
Plant seeds of beans and peas.

Does pupil or teacher enjoy most
This modern way of learning,
Where city children learn the truths
Revealed by the season's turning?

[2] Overstreet, Robert. "Bees Buzz . . . But They Don't Scare Children." *Houston Press*, April 15, 1952.

Do Stones Grow?

By GUY V. BRUCE
Professor of Science and Head of Science Department
State Teachers College
Newark, New Jersey

I CALLED at a kindergarten room to visit a senior practice student who was assigned to me for supervision. The regular classroom teacher was seated in her chair with about 20 children sitting on the floor around her. The children were scarcely at all distracted by my entry as I sat down to witness the procedure. She and the children were talking over some of their science experiences of the past few weeks. It was a regular practice of hers to do this, not so much for the purpose of review but more to amplify and extend their familiar experiences in the hope of yielding new problems to stimulate further activity.

They were discussing what they had learned about young birds coming from eggs. Their seeds had germinated at the window and they knew about the embryo plants in the seeds, and they had some plants growing in soil. They had learned about the basic conditions that are necessary for plants and animals to grow.

A GOOD QUESTION

One little boy came up with the question, "Do Stones Grow?" The teacher might have said, with a noticeable touch of disdain, "Why Frankie, who ever heard of such a thing. Of course stones don't grow." Instead this teacher said, "That's a good question, Frankie. What made you think of it?" Without relating the prodding of the teacher and patter of the children, all of which can be filled in by the understanding teacher who reads this, and the struggle of Frankie as if pulling his thoughts from the tips of his toes, these ideas gradually took shape from the half-formed thoughts that were turning around in Frankie's mind:

In all cases we have seen that big things have grown from little things. Birds come from eggs. Little birds grow to be big birds. Little seeds grow into big plants. We know, too, that there are tiny stones, and there are bigger and still bigger ones, and there are some as big as a house. Do the big ones grow from the little ones?

WORKING TOWARD THE ANSWER

This was all talked out until all the children saw the sense of the problem. Nobody knew the answer for certain; pretendingly, not even

the teacher herself. How can we find out? How did we find out about these other things? After thoughtful guidance they arrived at this decision: let us do the same with a stone as we did with the seeds. The children and teacher discussed the size of stone they should start with and it was agreed that each child should bring in a stone. They would then decide which one would be best to use for the experiment. I left them with the assurance that I had enjoyed being with them and that I would be interested to know what they found out.

MAYBE STONES TAKE LONGER

When I returned two weeks later, the children were enthusiastic about showing and telling me what was going on. They showed me the stone they had selected, an oval-shaped one. They explained why they decided this was the best of all stones that had been brought in, and why Edith's stone and Jerry's stone, and so forth, would not do so well. The stone was in a dish of water at the window near the radiator where the plants were growing. They had measured it around both axes periodically and they had also weighed it. The teacher had recorded the data for them in a square on the blackboard along with the dates. They were not ready yet to draw a conclusion, for some of the seeds had taken much longer than others to grow and perhaps stones take longer to grow than anything else in the world.

IS THIS ELEMENTARY-SCHOOL SCIENCE?

Whether we call this elementary-school science or something else, it would seem to boil down to just good teaching of young minds by a sympathetic and wise teacher. If this attitude of inquiry and method of search should continue thru the formal school life of these children, it would seem reasonable to assume that democracy ought to be more secure in their care when they assume the role of decision in the years to come.

Even in more placid times we must make decisions that affect our entire personal lives. Today we play a part in deciding issues of world-wide significance. It is science that can help us find the most appropriate solutions by asking a vital question in just four words: "How do you know?"

—ROBERT TYSON, "Science Challenges Disaster." *Science Teacher*, November 1951.

Blackbirds! Friend or Foe?

By WILLIAM S. WEICHERT
Associate Professor of Science
Eastern Montana College of Education
Billings, Montana

HERE is a copy of a letter the author of this article received one day from a group of fifth-grade children in a large city elementary school:

Fifth Grade
Whittier Elementary School
May 15, 1952

Dear Mr. Weichert:

Our class had a discussion this morning and we talked about birds.

Elwood said he would bring a specimen. He said he would kill a bird and Miss Smith seemed very surprised at Elwood.

Elwood said, "We do it all the time." We had some more discussion and we have a question to ask you: Do the blackbirds eat the wheat on Elwood's farm? Is it legitimate for Elwood to shoot the blackbirds? Our class would like to have you come and see us.

Yours truly,
Room 10

These children had a problem of vital concern to them. All of the children except Elwood lived in the city. To them, the shooting of "back-yard birds" just didn't seem right under any conditions. Of course, they had been taught to think this way. To Elwood, the killing of any kind of animal that destroyed his father's crops was perfectly legitimate business.

STATING THE PROBLEM

When the writer joined the class one day soon after receiving the above letter, the children gathered around in an informal circle. They had evidently arranged for a spokesman, as one little girl quickly told the story and stated their concern about the shooting of blackbirds. Elwood then told what he had observed and stated that he believed the blackbirds were eating his father's grain. The children did most of the talking with the writer throwing in questions here and there. We finally decided that we needed to get some information, and in order to get the proper kind of information, we should state our problem as clearly as possible. So we wrote on the chalkboard exactly what we wanted to find out. The problem was stated in two parts as follows:

1. What do blackbirds eat?
   a. Do blackbirds eat grain, and if they do, do they eat enough to be harmful?
   b. Do blackbirds eat insects? If so, do they eat enough to be more helpful than they are harmful?
2. Do we have laws that protect blackbirds from being shot?

LOCATING INFORMATION

After we had stated our problem, the group was asked if anyone had information which might help us in getting answers to our questions. Several children thought blackbirds were protected by law. Some thought blackbirds ate more insects than they did grain and would be more helpful than harmful to farmers. Elwood insisted that they were eating his father's grain in large amounts because they came in such big flocks. No one knew for sure. The next step was to decide how to get information bearing on the problem. Several suggestions were made:

1. Go to the library and search the encyclopedia and read books about birds and conservation of wildlife.
2. Write to the Audubon Club for information.
3. Write to the U. S. Department of Agriculture.
4. Write to the State Department of Agriculture.
5. Talk to the farm agent.
6. Ask the scientists at the local university.
7. Have Elwood watch the birds very closely to see if they were really eating grain and not just insects on the grain.
8. Examine the stomachs of blackbirds to see what they eat. (Elwood remarked at this point that they could not tell by looking in one or two blackbirds' stomachs just what all blackbirds might eat. This suggestion also precipitated a discussion of the kinds of stomachs birds have. Some of the children who had watched their mothers cut up chicken told about the chicken's crop and gizzard. The children also discussed how scientists studied the eating habits of birds.)

The class decided to write to several places for information, but for the time being they would depend on books from the Agricultural Extension Service of the university and perhaps from the local Audubon Club. The class asked the writer if he would get information for them from the university while they, in turn, composed letters to other agencies and looked up information in their library. They agreed to meet again in three days to discuss the findings.

BASIC CONCEPTS

Before the group closed its discussion, there were questions as to why man killed some living things while he protected others. Hunting

and fishing laws were also discussed. The children developed some basic concepts about balance in nature and learned that conservation means control of numbers of some living things as well as increasing the numbers of others.

THE TEACHER AS A MEMBER OF THE GROUP

During the discussion the children were permitted to talk freely and informally. The writer participated only as a member of the group, which means he *contributed* to the group work on the problem. Many people have the idea that if a teacher does not direct a group, he does not give it the benefit of his wider experience and mature judgment. One must remember that as a member of a group an individual has responsibilities for the progress of the group toward realizing its goal. A teacher, as a member of a group, can contribute in this way just as any member of a group can. However, he will never achieve recognition as a participant if he, in most cases, is directive and authoritarian in his methods of working with children.

At the close of the discussion an observer in the room asked the chil-

Henny Penny taught first-grade science.

Courtesy Norman C. Cooper, Los Angeles, California

dren to evaluate their discussion. He asked them if they were disappointed in not getting an outright answer to their problem from Mr. Weichert. Some of the children said "yes," but many of them, including those who participated most, said "no." One child expressed it this way, "If Mr. Weichert had given us the answers to our questions, we wouldn't have learned as much." Another said, "When we try to discover the answers to our own problems, we understand the problems better."

DRAWING CONCLUSIONS

As it turned out, the writer was unable to be present when the findings were discussed. He sent his evidence to the school in the form of several bulletins issued by the extension division of the university. The class concluded from the evidence at hand that:

1. Blackbirds are an agricultural pest and they do consume a large amount of grain.
2. Elwood's father had the right to shoot them.
3. Blackbirds are not protected by law but the cities have laws against using firearms within city limits.
4. Blackbirds do eat large numbers of insects but not enough to offset the grain they eat.

TEACHER-OPPORTUNISTS

Here, then, is an experience originated and carried thru by children. There is no reason to believe that these children are much different from most fifth-graders. There is no doubt that these children have enjoyed a superior type of classroom climate—a climate in which they have been encouraged to raise questions and go about discovering ways of getting answers. It is evident, also, that this teacher is an opportunist and that she recognizes the elements of a good learning situation. Nothing was allowed to stand in the way of consummating this problem as long as one shred of interest and purposeful activity remained. The plea in this article is for more teacher-opportunists and more learning experiences of this type.

The presence of the science "expert" in this situation was not at all necessary. There was nothing in this experience that the classroom teacher could not have handled. However, this particular teacher happens to be a person who utilizes every resource available to her. She draws on people, things, and places; she draws on the entire community. It was the children who suggested calling on the writer when she asked them for ideas on how to get information on their problem. It was an unusual pleasure to work with this alert group of interested and interesting fifth-grade children.

Harvey and the Mentally Retarded

By EILEEN D. KELLEHER

Teacher of Children with Retarded Mental Development
Public School 111, Queens
Long Island City, Long Island, New York

SPRING 1946 was a memorable time for the class of mentally retarded children in our school. That spring marked the beginning of our rise to fame and glory in the eyes of the other children in the school and in the neighborhood. And it all began with Harvey, a beautiful white, part-Angora male rabbit. Mr. Brown, our school custodian, presented us with Harvey right after the Easter vacation.

Harvey was only six weeks old, so the 18 youngsters who ordinarily found it difficult to do anything well were able to raise and train him. What changes Harvey wrought in our lives! Louis and his committee constructed a large house of wire mesh and Harvey became a solid citizen of our class.

He had the freedom of the room during school hours and was soon housebroken to papers in a certain corner. Everybody vied for the privilege of carrying him to the yard or the local park when we went out for gardening or physical training. Harvey became a neighborhood curiosity.

Albert was our chief expert on feeding. Albert was a nonreader, but that did not stymie him. Members of the science club read to him and he learned readily. Books on rabbit care suggested pellets and water. Mr. Brown (by this time, as deeply involved as the children) suggested carrot greens, carrots, and dry hard bread with a salt spool attached to the side of his house.

THE CLASS WITH THE RABBIT

The group was no longer the "dumb" class. It was the class with the rabbit and the teacher was the "rabbit lady." All kinds of tricks were resorted to to get into the class. Interest and pride in such a beautiful and intelligent bunny made the room a "must" on the visitors' list. Visitors need guides, and so it came about that Harvey wrought a miracle—the miracle of making Mary Ann speak. Mary Ann showed her deep feeling of inadequacy by hanging her head. She had never uttered a word since she came into the group. Nothing the teacher could do would make Mary Ann raise her head or speak—but Harvey did. Mary now had something to say to visitors.

The competition for Harvey's summer care was keen among the children. The class decided that Albert had given him the greatest amount of care during the school months and should be allowed to keep him for the summer. We were sure that Albert's energies would be channeled in the right direction during the summer. That he had done a very fine job was evidenced by the condition of Harvey in September. Here was a rabbit with personality, but more important, here was a boy who felt the satisfaction of achievement. Albert had experimented and told the class that Harvey had acquired a real taste for peeled apples. Needless to say, the children catered to Harvey's taste.

It must be said that Harvey knew how to attract attention. If things didn't happen fast enough or to his liking, he would quietly hop to the front of the room and push open the door. The resulting bang brought the attention he craved. This door-banging was also resorted to when visitors overlooked him in favor of the mice, rats, or guinea pigs which also lived in the room. The children's response to the slammed door was usually, "Here, Harvey, we love you too."

STARTING A FAMILY

In the spring of 1947 a female rabbit was acquired by the school for mating purposes. Now things began to happen. A blessed event was in prospect. Such preparations! Interest ran high thruout the school. The class and the school science club kept records of progress. Visitors trooped in and out all day, every day. Children were busy giving reports and answering questions. That some of us did not know how to read was no longer a shame. We had lots to tell and the whole school wanted to learn. And this time they were learning from us!

In due time we were presented with seven bunnies. Kindness was the rule of the day, for these new rabbits needed care. In the meantime, Harvey was still "king of the class" and cavorted more than ever. It was nothing to find him out in the main hall, but a clap of the hand or calling his name would quickly bring him back to the classroom.

Most of the family was "raffled off" to meet expenses. Once again summer was upon us. This time Mr. Brown took Harvey, and Mary Ann (the erstwhile silent one) cared for Smokey, one of the female bunnies.

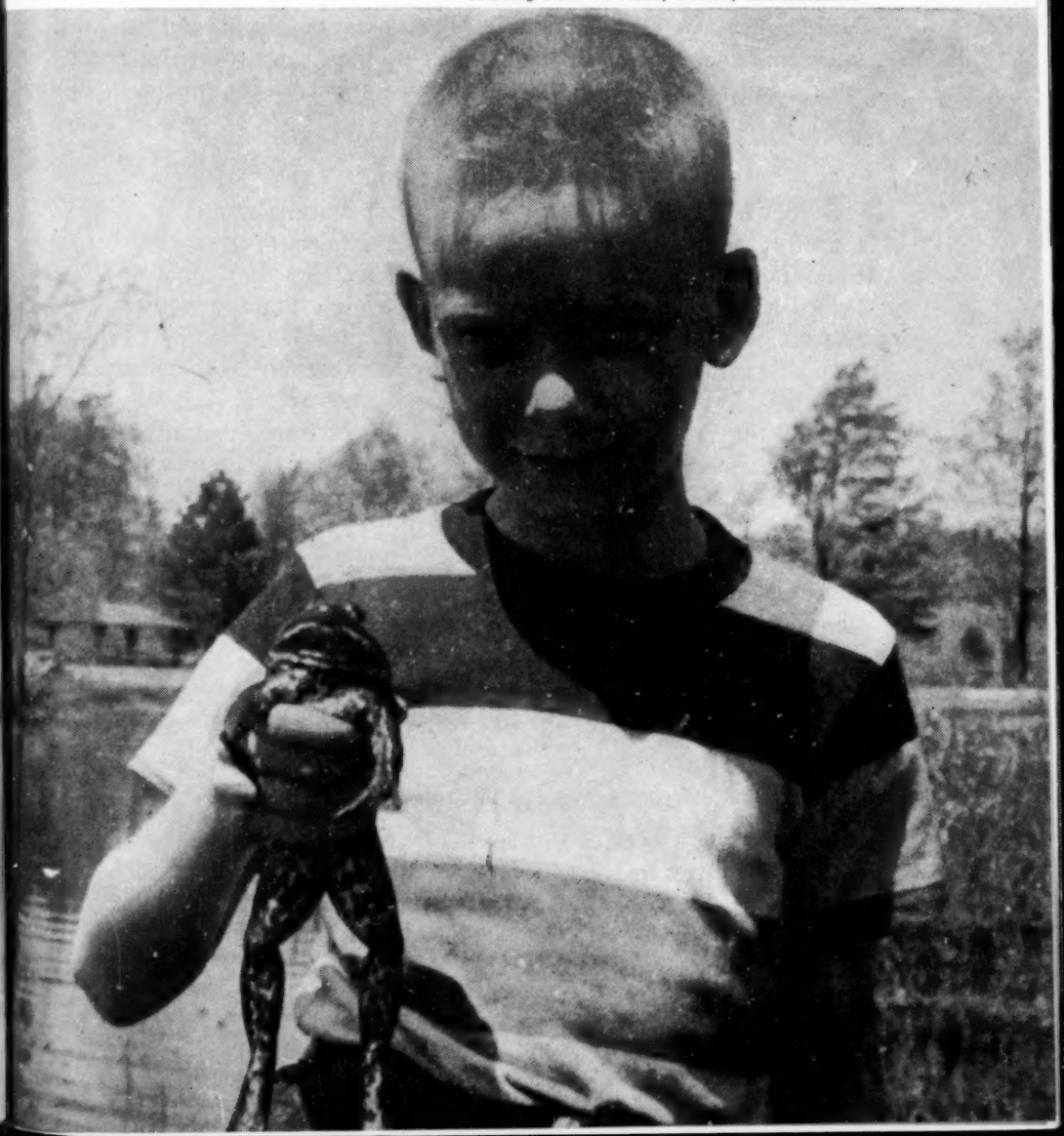
SMOKEY HAD FIVE

Harvey and Smokey returned to school from vacation. Things remained quiet with Harvey the center of interest until the spring of 1948. Once again, a family was in order. As the time for delivery approached, interest waxed great. Each child tried to do his part

toward making the event easy for Smokey. When Smokey began to pull fur from her ruff, Tommy placed a thoroly cleaned, well-lined nesting box in her house. The children had visited a local dairy barn and had asked for some clean hay for the lining of the nesting box. (An extra bagful of hay for house cleaning at the end of the second week was held in reserve.) An announcement of birth was posted on the bulletin board when Smokey presented us with five

A small stream or spring can be dammed so as to provide a bog garden where aquatic plants and animals can be placed for observation and study.

Courtesy John G. Read, Boston, Massachusetts



babies. This time, however, things did not go as smoothly as with our first rabbit family. We soon found that Smokey would not be able to feed all her little ones.

MEETING THE EMERGENCY

Tommy and Billy arrived with some doll's nursing bottles and a can of evaporated milk. A "formula" was made of milk, water, and a few drops of a vitamin compound. Schedules were arranged for a bottle for each baby rabbit twice a day. Such devotion and care! Of course, weekends presented a problem, but Mr. Brown came to the rescue and everybody heaved a sigh of relief. This bottle feeding was carried on for three weeks and we found ourselves with a litter of healthy, happy, and frisky rabbits, not to mention gleeful children who knew that they had saved these babies by their care. After this experience a full set of nursing bottles became standard equipment in our class. We were ready for any emergency!

THE "DUCHESS" ARRIVES

School reopened in September 1949 with one male survivor. A new four-story apartment for rabbits was Mr. Brown's suggestion at this time. This would accommodate both guinea pigs and rabbits. Louis helped Mr. Brown build the house and a Dutch bunny was purchased. She became known as "Duchess"—a gentle, lovable, pedigreed rabbit.

In February 1950 the class and equipment were moved to our present school, P. S. 111—a brand new building. May 25 was our dedication day and the 21st found us with a new litter of three beautiful rabbits. Such excitement! It was like starting all over again. The new building was a thing of beauty, but baby rabbits and a beautiful gentle mother were real and living. Some children in the new school had never seen live pets in a classroom. This was an experience to talk about! Kindergarten children laughed and shouted with joy when Duchess escorted her young ones to the yard for some exercise on the grass. Neighbors, too, stole a look and left smiling.

To bring the story up to date, we now have Duchess and Thumper, her offspring, along with Spotty, another son. There was no family this spring—an oversight on the teacher's part.

NOW IT'S LOUISE

A new interest entered our lives. Mr. Sarasohn, the man who sells crackers, was so impressed by the care and love we gave our pets that he presented us with Louise, a beautiful parrot that really talks. All eyes are now on Louise, our new feathered friend. For once rabbit raising is taking a back seat.

Studying the Earth

By AARON R. SMELKINSON
Classroom Teacher, Arlington School
Baltimore, Maryland

WHEN front-page headlines on December 4, 1951, broke the news that the Hibok Hibok volcano in the southern Philippines had erupted and was spewing lava and ashes over a wide area, at least one sixth-grade class understood what was happening on that unfortunate island. The eruption occurred one week after my pupils at the Arlington Elementary School had begun a rather intensive study of the nature, causes, and location of volcanoes, as part of the science unit entitled "Story of the Earth."

It is not often that a science teacher gets such dramatic assistance from nature in demonstrating how real, meaningful, and timely are the problems under consideration in the classroom. For my sixth-graders the story of the Hibok Hibok upheaval resulted in a surge of renewed interest, not only in volcanoes but also in the study of earthquakes, rivers, rocks, and glaciers, which had been introduced by this time.

As if to exploit the coincidence to the fullest degree, requests came to us from two other sixth-grade classes to send representatives to their rooms for the purpose of sharing our knowledge of volcanoes with them. Bursting with pride and armed with charts, books, pictures, and diagrams, two delegations of five children each eagerly sallied forth to inform the other sixth-graders how and why volcanoes are born, what takes place during an eruption, how volcanoes change the surface of the earth, where they may be expected to occur, and when they may be expected to become extinct.

VOLCANOES VERSUS EARTHQUAKES

The misery and death wrought by the Hibok Hibok eruption remained fresh in the pupils' minds as reports of additional eruptions by the volcano continued to occupy prominent spots in the newspapers for days afterwards. By this time we were deep in the study of another great natural phenomenon, the earthquake, and the children began comparing the relative destructiveness of volcanoes with earthquakes. There was a demand for my opinion as to which of the two was worse. Having in mind the multiple-learning experiences that would evolve, I suggested a debate on the question, a proposal the children seized upon with alacrity. Two teams were chosen—three

members and a rebuttal on each side of the question: "Resolved, that volcanoes are more destructive than earthquakes."

Before the day of the debate, pupils went digging into class, library, and home reference books to ferret out information on the great volcanic eruptions and earthquakes in history. The mother of one of the debaters reported to me later that she had rarely seen her boy voluntarily seek information from her home set of encyclopedias before. But he did this time—feverishly, excitedly, eagerly.

With the class acting as judge, the affirmative side won the debate. Altho the pupils applauded the winners enthusiastically, the outcome was—to me, at least—unimportant. What I enjoyed was the fact that one child in presenting a rebuttal seriously damaged his opponent's argument by citing evidence to show that much earthquake destruction is due to panic and to the lack of adequate precautionary measures, rather than to the earthquake itself. Another warming incident was the exposure by one little girl of an opponent's point as hearsay and unfounded rumor rather than a scientific, authority-backed fact.

INTEREST IS AUTOMATIC

From the very beginning of our study of the earth, the children, almost without exception, exhibited such a degree of interest in the work that any artificially contrived motivation on my part was unnecessary. Of all subjects, science appears to be the one least calculated to produce boredom, disinterest, or resigned acceptance. Upon the signal "clear the decks for science," backs straighten, hands clap with glee, eyes brighten. The word science need not be mentioned. Pupils "instinctively" sense the launching of a discussion which brings them into contact with fresh, surprising, and hitherto unrevealed information concerning their environment.

INTRODUCING THE UNIT

The unit on the earth was started off by recounting what early people once believed about the origin of the earth and about the reasons for such events as earthquakes, floods, or volcanic eruptions. In the latter instance, for example, an angry god was supposed to be living in the volcano and showing his wrath and displeasure at the sins of the human race by means of spectacular volcanic fireworks.

I watched the amused grins, the disbelief, the scorn; then pointed out that until the advent of science, superstitions such as these were very generally held. After this beginning, the children were drawn into a discussion of what *they* believed were the reasons and explanations for natural phenomena. From that point it was easy to show that

Courtesy John G. Read, Boston, Massachusetts

The necessity of using some means of reducing friction was understood by all pupils.

they, too, had many misconceptions—mistaken ideas which would be cleared up in the course of our forthcoming study of the earth.

THE PROBLEM-SOLVING APPROACH

Thruout the unit, liberal use was made of the problem-solving method in each phase of our study. Under guidance, the class successively defined the major problems as: (a) What is the age of the earth and how can scientists determine it? (b) What is inside the earth? (c) What forces of nature help build up the earth's surface? (d) What forees of nature tend to tear down the earth's surface? (e) What was the earth like millions of years ago? (f) How do we know what living things were like long ago?

Much planning, care, and effort went into making as certain as possible that the problems posed were those of the children, either by creation or by *voluntary* adoption. That is, no step was undertaken toward suggested methods of solution or toward the solutions themselves until the pupils thoroly understood the problem as stated, and indicated that they desired and *needed* to solve it.

To illustrate this point, when planning to start a consideration of forces which tend to tear down the surface of the earth, there was evi-

dence that the children had only a nebulous idea of what was involved in the question and that they did not feel the problem was important enough to need a solution. I tried to change the sentiment by showing numerous pictures and engaging the pupils in discussions of the magnificent Grand Canyon and other scenic wonders. While expressions of admiration and awe emanated from the class, I asked for opinions as to the way the Grand Canyon site probably looked millions of years ago. It was gratifying to see the heightened interest and spark of comprehension in the pupils at the disclosure that the original appearance of the land might have been quite unimpressive—nothing more than a stream flowing along in a slightly hilly region. In like manner, interest was aroused in the origin and past history of certain local stream valleys familiar to many of the children. At this point they began to ask whether other natural forces caused similar changes in the earth's surface. Here, then, was the problem—all but defined.

EXPERIMENTS AND ACTIVITIES

The class made use of various types of activities during the course of the science unit. A large number of simple experiments were carried on, such as dampening the blackboard to detect, by smell, the mud origin of slate; or bending a brittle stick until it broke, to simulate the jar or shock accompanying an earthquake. Other experiments included bringing a pot of cereal to a boil, to produce the effect of an erupting volcano with the crater forming at the top; identification of limestone or marble by noting the presence or absence of chemical reaction when hydrochloric acid was applied to rock samples; and pouring water over mounds of sandy soil, once slowly and then with a gush, in order to observe the relative effects on the soil and the type of sediment carried away in each instance.

In addition to the experiments and activities described earlier in this article, the children also had the following experiences: writing letters to government agencies and universities requesting information on volcanoes, earthquakes, and geysers; making a collection of rock samples and labeling them according to their general classification, i.e., sedimentary, igneous, or metamorphic; consulting newspapers and current magazines for reports of recent natural phenomena; writing and acting out original dramatizations, one of which depicted the geologic ages and involved a host of prehistoric animals; making charts and diagrams, preparatory to explaining the earth's origin, the earth's composition, volcanic activity, formation of caverns, and the like; setting up bulletin-board displays of pictures showing the changes in the

earth's surface caused by wind, river, glacier, and underground water; conducting quizzes in which particular prehistoric animals were described, the audience being required to identify the animal; occasional trips outdoors to study rock formations or to examine the soil after a heavy rain. An especially effective aid in the comprehension of a difficult but important concept was the drawing of a time line, to show the enormity of geologic time as compared with time units familiar to the children.

DISCUSSION PERIODS

Of all the types of activities engaged in, probably the most essential one for the realization of the objectives of the unit was the discussion period, which we held at regular intervals thruout our study. It was during these periods that a number of misconceptions or distortions were righted; half-perceived ideas or principles clarified, elaborated on, and clinched; valuable experiences shared and added to the children's background information. An improved scientific attitude was fostered by mutual evaluation and criticism of questionable statements or conclusions. Above all, since children tend to become absorbed in interesting detail and to neglect the over-all picture, our discussions served to bring together loose ends and to refocus attention on major concepts. For example, one boy had become so absorbed in working with the class rock collection—testing color, hardness, and streak; splitting and applying chemicals—that he could not answer the question, "What connection does the study of rocks have with the story of the earth?" A lively class discussion ensued, during which it was brought out that it is mainly thru the study of rocks that scientists are able to reconstruct the history of the earth and of living things.

MAJOR CONCEPTS

Near the conclusion of the unit, the children were given an informal oral test to determine the extent to which they had grasped the large, basic principles and meanings involved in our study. It was gratifying to note that apparently they had learned well the following concepts:

1. The earth is very old.
2. The earth's surface has not always had its present appearance and it is constantly changing.
3. Great changes have occurred in the climates of various sections of the earth.
4. Natural forces are responsible for changes in the earth.
5. Living things must adjust and adapt themselves to their environment or else they will perish.

Sixth-Grade Weather Prophets

By GEORGIE McCULLAR and MILDRED S. KIEFER
Classroom Teacher and Intermediate Supervisor
Phoeniz, Arizona, Elementary-School District No. 1

HAVE you ever walked thru a cloud?" This question by the classroom teacher and the exciting experience she told brought such an avalanche of questions, opinions, and arguments that the sixth-grade class of Whittier School was well into the unit on weather before we could say "Jack Robinson."

TESTING WEATHER SAYINGS

After several statements about ground hogs and the heavy coats of animals foretelling weather conditions, the group decided to find out which statements were true and which ones were not.

The intensive reading done by the group resulted in two summarizing columns of statements, weather sayings which were true and those which were not. The latter were recognized by the children as superstitions. As the pupils considered the great number of these superstitions, they quite naturally decided that it would be profitable to study the weather station in order to find out how this agency helps people replace superstitions with scientific understanding. The many instruments of the weather station, their uses, and the many people to whom weather is important were topics for consideration.

CREATING A HOMEMADE WEATHER STATION

At this point in our unit a most fortunate coincidence occurred. The magazine *Life*[1] ran a two-page spread about a "junior weatherman" who had made his own weather station using milk cartons, jars, rubber bands, paper clips, and a few needles and pins. The excellent book which the article recommended, *Everyday Weather and How It Works*,[2] was read and reread, and it became the final authority for our group.

The pupils were eager to make the instruments, but when they realized that they did not know enough, they read for more information and took notes. They discussed the importance of taking only

[1] Life. "50-Cent Weather Bureau." *Life* 32:67-70; August 6, 1951.
[2] Schneider, Herman. *Everyday Weather and How It Works.* New York: McGraw-Hill Book Co., 1951. 189 p.

useful notes and the necessity for eliminating repetition. In order to prove their statements, as well as to have a reference for future needs, they made a bibliography which was kept in the back of their science notebooks.

This research was interspersed with discussions, reports on fairly new discoveries about weather, and many interesting experiments which the group thought should be tried. At first the boys were much more interested in experiments than the girls, but as the unit progressed the girls equaled the boys in enthusiasm and interest. Some were interested to the extent that they got their fathers to help them make some of the equipment at home.

EXPERIMENTING

Most of the experiments were simple and were recorded in the pupils' notebooks.

Two boys proved that air has weight by weighing a basketball filled with air and comparing it with the same one empty. That fire requires oxygen was demonstrated by two "reluctant readers" using a candle, glass jar, saucer, and glass of colored water. The explanations they made to their classmates were very short and simple and went something like this:

First boy: Fire takes the oxygen out of air. If fire does not have air, it will go out. That is why I am careful to close the doors and windows during our fire drill.

Second boy: This candle is burning. I will place this jar, which looks empty but has air in it, over the candle. Now I pour this water around the jar. When there is no more oxygen in the jar, the air pressure from the outside will force the water up into the jar because there is room for it now.

The class was delighted with the experiment and the boys were pleased with themselves! It was a thoroly satisfying experience which gave them status with their peers.

MAKING WEATHER INSTRUMENTS AND A CALENDAR

The group kept a weather calendar showing the temperature in the room at a certain time each day, as well as the cloud formations and wind direction and speed. We even predicted the weather for the next day with our own homemade weather instruments. When we felt we were ready, we made a wind vane, barometer, hygrometer, air-current indicator, a weather wheel, and an anemometer. Materials used were paper clips, milk cartons, paper cups, straight pins, a needle, a jar or two, and rubber bands. Everyone was so interested that it was difficult to pry anyone away from the "laboratory," a corner of the room

where the materials were kept. A major catastrophe threatened us when the only girl in the room who had hair long enough for our hygrometer almost moved out of the district!

PLACING INSTRUMENTS OUT OF DOORS

We had a problem locating our weather instruments where they would be safe and yet help us to forecast weather. The barometer performed satisfactorily in the closet, but practically everything else worked only out of doors. We decided that the boys, with the help of our shop teacher, could make a small platform which would fit over our window sill and extend beyond for about two and one-half feet. This could be removed each evening and placed inside the room, and be replaced in the morning. The group decided the window platform would assist future sixth-grade children in obtaining more accurate readings.

ASSESSING BYPRODUCTS

A news clipping brought to school by one member of the class introduced interesting problems dealing with numerical averages. The article listed temperatures 20 and 40 years ago. One boy who loves figures, charts, and graphs, decided that he would compare our present weather for a 10-day period with that of 20 and 40 years ago. This led us to story problems of various sorts and gave practical meanings to such useful terms as degrees, highs, lows, maximums, minimums, and averages.

In order to make our charts and posters, we needed to know how to divide paper equally, and this naturally led to division and fractions. Some of our charts were excellent except for the manuscript writing. With the help of our art teacher we were soon writing neatly and legibly.

VISITING THE WEATHER STATION

At different times we had discussed the possibility of visiting the weather station at the airport. Now we began talking in earnest about the trip. We wrote to the proper authorities requesting an audience. In due time a reply was received and permission to visit on a certain day was granted. Because the school bus was not available at that time, some of the mothers took us. Later, the mothers expressed delight with the trip, commenting on the children's "excellent" behavior, their poise when being introduced, and their expressions of gratitude to the weather station personnel. They commented also on the organization and preparation for the trip which had obviously preceded the journey.

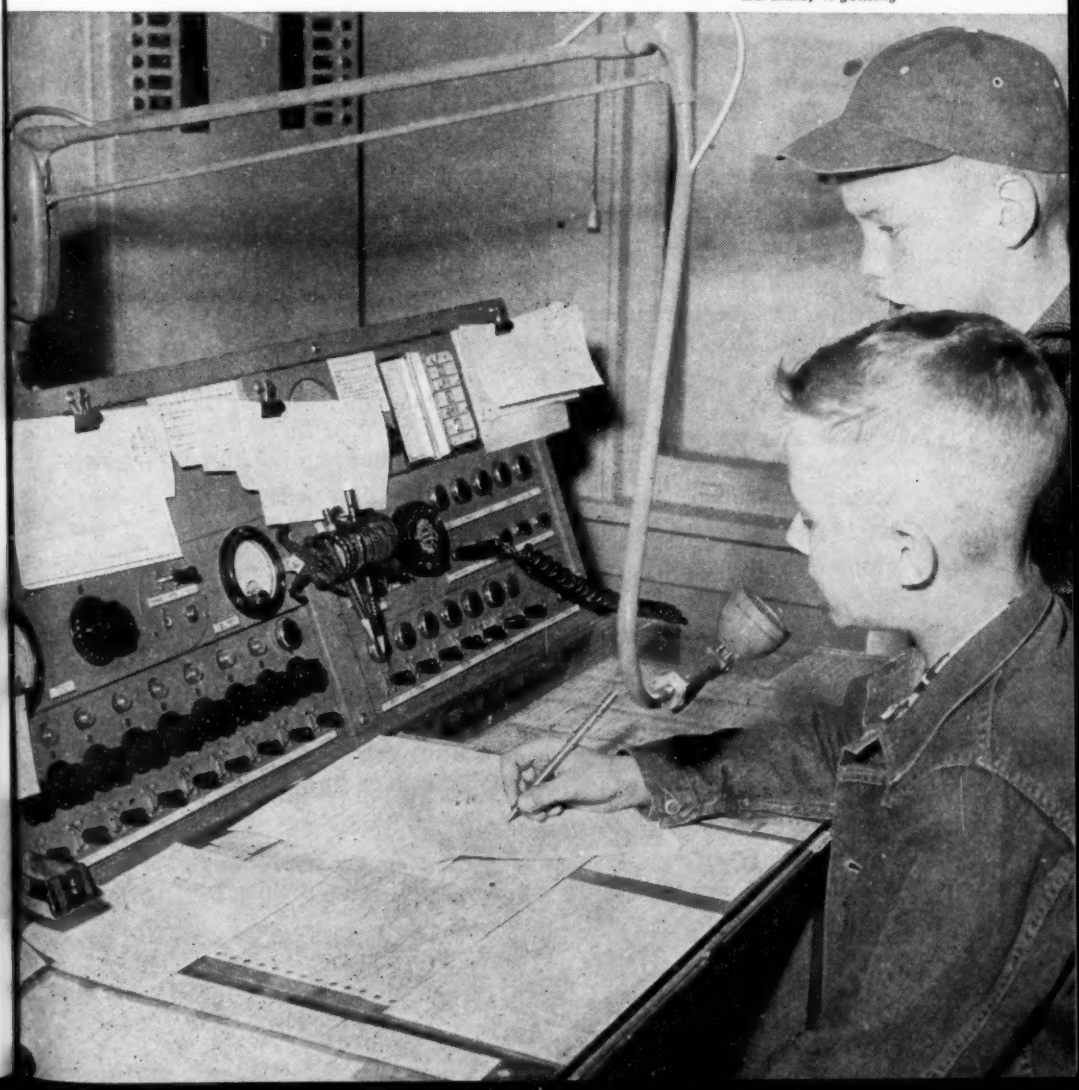
While at the station the class listened quietly and asked intelligent questions. Watching a man who was making a weather map, one boy pointed and whispered, "There's a cold front and this means rain!" Undoubtedly the high point of the visit was when a balloon was released to find the wind direction. The class watched until it was a mere pin point.

PLANNING A CULMINATING ACTIVITY

To culminate our unit, we decided to stage a short program reviewing our activities, and to invite the other sixth-grade children, the principal,

Fourth-graders gave weather information to pilots from the local airport.

University of Wyoming Elementary School
Laramie, Wyoming



and the supervisor. After some discussion we decided to give a few highlights of each of our activities.

One was a play which, like "Topsy," just grew. The children who had made weather instruments decided that instead of just explaining the how and why, they would dramatize their activities. Each child wrote his own part, and the questions he wished to be asked were supposedly those of a small boy talking with his mother. We wrote only enough to produce the necessary organization, as I felt the children's enthusiasm was the most important element and should not be jeopardized by too much rewriting. A boy who usually stammers badly explained in his talk how I had taken him and another boy in my car, and how he had counted the times the anemometer turned in 30 seconds, thus being able to compute how many miles per hour the wind was blowing! His whole explanation was without a quaver. He showed much poise and even wanted to "pad" his part.

CONTINUING ACTIVITIES

Weather is such a fascinating subject and has so many different channels for learning that it was difficult to bring the unit to a close. Final activities included the study of the colors of the rainbow. We discovered how to set a glass of water in the window in the sun and have our own private rainbow on the floor on sheets of white paper. We learned about warm and cool colors, northern and southern exposures, and even touched on interior decorating. We discovered that a great deal of arithmetic could be learned by drawing to scale plans for a few rooms.

REFLECTING ON VALUES

As I thought thru the intellectual, social, and emotional values which accrued from the experiences, and recalled how personal satisfactions became intermingled with, and contributed to, the solidarity of the group, I found myself in agreement with a recent statement of Alvina Treut Burrows:

> The kind of group experience which offers both individual release and group unification is worthy of more class time and much more professional study. . . . Contributions to a group venture, whether the planning of a trip, the giving of a play, or the rounding out of an informational program for parents, earn a double reward—particular and specific learnings and status in a group—which in turn makes further learning easier and more to be desired.[3]

[3] Burrows, Alvina Treut. *Teaching Children in the Middle Grades.* Boston: D. C. Heath and Co., 1952. p. 264.

One Square Foot of Soil

By AUDREE WEBB PRATT
Classroom Teacher, Elm Street School
Erwin, Tennessee

OF ALL the projects undertaken in my 14 years of teaching, none afforded so much pleasure to both pupils and teacher as the study of a square foot of soil.

We chose our square foot of soil in a woodland where both deciduous plants and conifers grew. Our surroundings were studied and the birds we saw and heard were discussed. We talked about their contribution to and dependence upon the soil. Then we began surmising about other small animals, such as rabbits, squirrels, and snakes, which in all probability inhabited the woods. Pine seedlings were pointed out and a discussion of how plants reproduce followed.

The plant life on our soil was next in order. There we found fern, bloodroot, and bellwort. We talked about the characteristics of the fern—its need for much moisture and little sunshine; its clean, spicy odor. The boys and girls described other wild flowers they had seen in the woods including lady's slipper, jack-in-the-pulpit, trilliums, dutchman's breeches, trailing arbutus, and many others.

The leaves next to the soil were found to be in a state of further decay than those near the top. We had previously studied the formation of soil; therefore, we had some idea of what we should find. The topsoil was very loose and some of it could be easily identified as parts of leaves, plants, roots, and fallen twigs. One very interesting discovery was what had apparently been a small tree limb in which many minute white insects were busily working. This wood was in such an advanced state of decay that on squeezing it in the hands it crumbled to very fine particles.

In handling the soil, we observed its loose porous condition which enabled it to absorb water readily. The roots of the plants stored up water for future use and also further slowed the process of the sinking of the water. As we dug deeper into the soil, we noticed that it tended to be more compact until we reached some that was almost claylike in consistency.

We observed that on cold days the soil felt warm to the touch; on warm days it seemed cool. In comparing this with the breath of human beings, we concluded that, like body temperature, the temperature of the soil probably remained fairly constant.

Dearborn School, Roxbury, Massachusetts

The candle in the middle sized jar went out next, while the one in the largest jar took about one minute.

Rock types were discussed, and the fact that limestone was found in this area was proof that at one time the area was covered with water. A reddish streak in the soil, which we decided showed the presence of iron, led to a discussion of minerals.

Then we saw our first earthworm. That brought about a lengthy discussion of fishing on which the teacher was something of an expert.

Later we read about the earthworm and the part it plays in the development of soil. We found that no other animal played a more important part. It thrives in heavy, productive soil which is rich in lime and organic matter. The entire topsoil may be worked over by earthworms in 35 to 70 years. Ants, the larvae of insects, and many other animals, such as ground squirrels and woodchucks, aid in the mixing of organic matter with soil and in its general improvement.

Our study would not have been complete without a trip to a badly eroded piece of ground. This was easy to find. We contrasted the two types. The eroded land had no plant life, the soil was yellowish in color and as hard as concrete, and there was no animal life.

Besides being an informative, practical study, this unit was intensely intersting. It made the boys and girls more conscious of the importance of conservation of natural resources than any other approach I have ever used.

Growing New Plants from Old Ones

By LOIS MEIER SHOEMAKER
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New Jersey State Teachers College
Trenton, New Jersey

IN TEACHING how new plants are produced, a classroom teacher can select worthwhile material which will be not only appropriate but also decorative in the schoolroom for a long time. Wherever such material is available, pupils can share in the experiences of planting and take their plants home to enjoy.

NEW PLANTS FROM ROOTS

Support a sweet potato in a jar or dish of water. Buds will appear on the root and an attractive vine will grow. The food for growth is supplied by the root until the green leaves take over the process of foodmaking.

NEW PLANTS FROM STEMS

Make cuttings ("slips") several inches in length from geranium, wax begonia, coleus, inch plant, or philodendron. Make a clean cutting on an angle with a sharp knife. Remove all but two or three leaves to cut down water loss while the slip is rooting. Place each cutting in soil in a flower pot, being sure that at least one node (the point from which a leaf comes) is under the soil. A suitable soil is made with one-third sand and two-thirds garden loam. Keep the soil in the pot moderately moist and place the pot in a sunny window.

Inch plant and philodendron are vines; these slips, therefore, may be planted in the same pot with geranium, begonia, or coleus, which have upright stems.

NEW PLANTS FROM LEAVES

Take a leaf of African violet and place the petiole, or stalk of the leaf, under soil (one-third sand and two-thirds garden loam), pressing the soil firmly around it. Keep the soil moist.

Cut a piece of sansevieria leaf 2 inches long, and place the piece just under a layer of soil in a flower pot. Again, keep the soil moist.

A leaf from bryophyllum, sometimes called airplant, produces new plants along the margin. If the leaf is placed in soil, many new plants are produced from it.

Weeks will go by before new plants root and send up a shoot from leaves, so it is best to put the leaves in a pot with a stem cutting or with some plant that is already established which one waters daily. Several stem and leaf cuttings can be put in a wooden cheesebox or in a large flower pot, in which they are not so apt to dry out over week ends as in small individual pots. The box or pot can be set in a pan containing a little water to tide the plants over week ends.

NEW PLANTS FROM BULBS

Paperwhite narcissus bulbs are grown in dishes of water supported by pebbles, crushed shell, or mineral-tile flooring material. Transparent dishes are preferable because children can see the root growth.

A refrigerator dish about 8 inches long and 4 inches deep makes a good container for three bulbs. Place a half-inch layer of pebbles on the bottom of the dish. Lay each bulb, stem end up, on the pebbles and fill in around the bulbs with more pebbles, leaving an inch of space at the top. Fill the dish with water to the top of the pebbles and set it in a closet for about a week until a good root growth is established. Then place it in a sunny window. Change the water every few days by holding the dish at an angle under the faucet, replacing the old with fresh water. If tepid water is added each morning, the blooming will be hastened. The bulbs will bloom in about three weeks.

Curiosity and joyous quest are part and parcel of the enchanting field of science. An approach to learning through such a quest, moreover, is in accord with the philosophy of the child-centered school. Learning comes about through active participation in situations of real and immediate meaning to the learner. The field of science is replete with such situations. Hence it is entirely contrary to the spirit of science teaching to formalize and standardize procedures in this fascinating realm of discovery and exploration.

—*Science in the Elementary School*, California State Department of Education, 1945.

Teaching about Rust in the Third Grade

By JOHN G. READ
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Boston University
Boston, Massachusetts

HAVE you ever lost something and found it later on? And was it just the same as before? Puppies are sometimes fatter, but usually they are thinner if they have been lost. Dollar bills are often all soft and torn. But spoons and dishes and knives sometimes get lost in the sand or in the garden, and when they are found again they are much different.

THE BURIED JACKNIFE

Here in this box of damp soil was "lost" (of course, you know that I put it there!) a jacknife. It belonged to the twins who come to visit me sometimes, Phyllis and Fred. But it has been here in this box of dirt since school started. Let's dig it up and see what it looks like.

What a change! It was a shiny, sharp knife last fall, and the blades opened easily. It would cut sticks on which we could cook frankfurters. It could cut fingers! And now it is no longer shiny. It is red and black with—what? Yes, rust. The rust has made the blades stick to the handle. The blades can be opened with a pair of pliers, and we can see that the edges are all rusty too.

If we polish the blade with a piece of sandpaper like this, we can see the bright metal is still there, but it is all full of little pits. The rust has somehow come from the steel and the steel is gone. There has been a change; steel has changed to rust.

EXPERIMENTING WITH IRON FILINGS

Perhaps we can see this happen. Robert made some iron powder by filing some old nails at home—it took him a long time. (The machine shop where we got the filings last year burned down.) We will sprinkle some of the iron filings on a cloth which we will dampen with water. Then we will roll up the cloth loosely.

A day passes.

Let us unroll the cloth we used yesterday in our experiment. Look here! The powder has rusted. It is quite red. The iron powder has changed to red rust. The scientist calls this a chemical change Water seems to help make this chemical change happen faster. Is

there any way we could prove that water makes rusting go on faster? Yes, we can do this experiment using a dry cloth, or we can bury a knife in very dry sand or dirt. Dorothy has suggested that salt water makes iron rust very fast. She goes to the beach every summer. We can test that, too, can't we? Let us make these tests using the iron filings and more pieces of cloth, and watch what happens in the next few days. Perhaps some of you would like to do these or other experiments at home. Elizabeth suggests that we try putting things into glasses of water, some in fresh water and some in salt water, and see if they will rust. We might try all kinds of metals.

TABULATING RESULTS

Well, now that we have done all these experiments, we should get our results down on paper. The scientist keeps an accurate record of his experiments. Then other people can read what he did and check up on him. Might he be mistaken sometimes? Maybe he had a special kind of iron filings or powder that was different from your filings!

So let's make a table.

Directions: Write a large "R" if it rusted; a little "r" if it rusted just a little; an "N" if there was no change.

Metal	*In wet cloth*	*In dry cloth*	*In cloth wet with salt water*
iron filings	R (1 day)	N (4 days)	R (1 day)
iron nails			
old knife, steel			
silver knife			
silver spoon			
brass ring			
gold ring			
aluminum foil			
"tinfoil" (lead)			
copper penny			
copper wire			

Perhaps we need to put down how long the thing was in the cloth. You could put the number of days or hours beside each letter you write in the table. Now you can make another table showing what happens with glasses of water.

IDENTIFYING OTHER FACTORS

We have found that iron filings and nails rusted a lot when they were in wet cloth, but very little when they were in the bottom of a glass of water. What could make the difference? What is there in the cloth that isn't in the glass of water? Cotton—yes. We could put

some cotton cloth and filings in the bottom of a glass of water and watch that. Walter, you take care of that experiment. Meredith says there might be some starch in the old shirt we tore up. She will do that experiment, using the collar of the shirt and some starch, with the iron filings rolled up and the whole thing in a glass of water.

And now we shall need to do some reading to see if anyone else has tried some of these experiments. What are some good words to look up in the index of your books, in the dictionary, or in an encyclopedia? Yes, . . . "rusting," "iron," "steel," "salt," "cotton," "water," "chemistry," and "chemical change." Let us go to work and report tomorrow on what we find. Write down your reports in a few sentences and let me see them so we can plan our next lesson.

PREVENTING RUST

Now that we have found that it isn't only the water that causes rusting after all—that was a surprise, wasn't it—perhaps we can tell some ways of keeping the air, or the *oxygen* which is in the air, from reaching iron or steel and causing it to rust. You tell me and I will list them:

Covering with: oil, paint, nail polish, wax, waxed paper (sometimes), water (sometimes, for a while).

Covering the iron or steel with one of the metals we found did not rust, like: copper, silver, gold, aluminum, brass, tinfoil. (These have to be put on tight with electricity, Paul says. He will show you next week how copper can be put on a nail. He will bring in his chemistry set.)

Miss March's class next door says that when they went to the post office last week on a trip, they saw a new building with steel beams. The beams were all painted bright orange. Would you like to know what is in paint that keeps iron from rusting and why copper, gold, and aluminum do not seem to rust? Well, no one can say why they do not rust, but if you study chemistry you will see that all things that do rust are alike in one way, and those that do not rust are like each other. And we can do many more experiments with rust as we study science at home or in school.

It is apparent that the elementary school in our own country is more responsible than any other single agency for the thinking and behavior of the coming generation. One basic purpose, then, of science in the elementary school is to contribute to the development of desirable social behavior.

—GERALD S. CRAIG, *Science in Childhood Education*, Teachers College, Columbia University, 1944.

Planning a Flight into Space

By JOHN STERNIG
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Glencoe Public Schools
Glencoe, Illinois

SPACE ships will be a reality before the close of this century. This statement is no longer made only by science fiction writers. Scientists are now conducting experiments with rockets which will lead to space flight as soon as our government or others are ready to spend the vast sums needed.

A COLUMBUS OF 1992

The Columbus of 1992, who will rocket off to another "new world," is probably already born. Parents and classroom teachers need to provide more than comic books and television to prepare him for the new age of space flight and discovery which is to come.

Schools must provide *facts* about space flight and astronomy but such facts are now too frequently neglected. As a result, children are gaining their ideas from fantastic TV programs and comic books. They get the impression that astronauts will be able to rocket from planet to planet, from star to star, and even to the outer galaxies in a matter of days or weeks. Sober facts restrain such wild ideas, even tho they substantiate the imminence of space flight in our time.

CLASSROOM FLIGHTS INTO SPACE

The children of the Glencoe, Illinois, public schools have carefully planned experiences, designed to appeal to the child's adventurous spirit and at the same time to provide a solid core of facts and information about rockets and space travel.

The writer has conducted "classroom flights into space" at all age levels, primary thru eighth grade, and with adults as well. There is readiness and intense interest in every group just waiting to be used.

While the specific experiences vary from group to group, the following description is typical of the activities which have proved very satisfactory in the intermediate grades. Children's questions form the core of each experience.

Is It Possible To Leave the Earth?

In answering this question, we examine all the means of flight at man's disposal. We discover that all aircraft require air for flight and

that they could not be used in space. We consider the nature of space and study the rocket as the only means now known for flight there.

The principle of the reaction engine is explored and demonstrated with a balloon. The balloon is inflated and released to show how reaction to the action of the escaping air drives it forward. The action-reaction principle is studied in other connections and applied to rockets.

Pictures and movies of presentday rocket experiments dramatize the reality of rocket flight into the upper atmosphere.

How Fast Must a Rocket Go?

We learn that release of energy equivalent to seven miles per second is needed to escape the pull of the earth's gravity. We study what happens in the condition of "free fall" in space, and discuss in detail life on a space ship in terms of temperature, gravity, meteor and radiation danger, food, water, and air. The requirements of a space suit are studied and the pupils design suits which meet the requirements. Models of rocket ships and drawings of all kinds are made.

How Far into Space Can We Go?

Using "speed of release" (seven miles per second) as a standard, we figure how long it takes to go places, and we discover some interesting facts:

To the moon	10 hours
To Venus	43 days
To Mars	58 days
To Mercury	83 days
To Jupiter	2 years
To Saturn	3 years
To Uranus	7 years
To Neptune	12 years
To Pluto	17 years
To nearest star	120,000 years

These figures help us realize that only the nearest objects in space could be reached in reasonable periods of time. We discover that even light, traveling 186,000 miles per second, requires years to reach us from the stars, and millions of years from the outer galaxies.

Let's Take a Trip

Having established some basic facts about means of space flight and some of the limitations, we then proceed with imaginary trips to the moon, Venus, and Mars, since these will be within reach first. We study first what conditions life requires and find four absolute essentials: (a) proper temperature, (b) air, (c) water, and (d) food.

Science and astronomy books tell us what the conditions are on the moon, Venus, and Mars in regard to these essentials. We also consider what preparations will be required to enable man to survive on these worlds. We learn all we can about the space platform project which will provide an artificial earth satellite to be used for the take-off on our space journey. We consider how we can return to the earth. Again models, pictures, and dramatic and literary expression provide an outlet for creative ingenuity as facts are interpreted thru them.

A trip to the observatory at Northwestern University enables the children to actually see the moon, and sometimes Venus and Mars, thru the telescope which brings these objects "down to earth." At the conclusion of our project the group prepares a play, a series of illustrated reports, an exhibit, or some other means of sharing information with other groups in the school. This often starts other groups on similar projects.

ASTRONOMY COMES ALIVE

In this way our children learn the *facts* about space flight and integrate them with data on astronomy and modern developments in other sciences. Astronomy thus becomes alive and real to the modern child as we prepare him for the world of the future.

USING RESOURCES

A study of rockets and space travel demands use of current books and periodicals. Textbooks usually have little to offer. The local library will provide help on request. Children should be urged to bring in magazines like *Life, Popular Science, Scientific Monthly, Colliers,* and *Scientific American.*

Within the comprehension of children, the application of the scientific method is a matter of securing the correct explanation, or, if that is not definitely known, of finding the best explanation. It is evident that children do not discover new facts for mankind; but they do discover new facts for themselves and they must do that day by day if they are to become fully equipped for the age in which they will live.

—*Science Education in American Schools,* **Forty-Sixth Yearbook, Part I, National Society for the Study of Education.**

A Simple, Safe Volcano

By HANOR A. WEBB
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YOU can certainly say this about the classroom volcano: it creates interest! As a demonstration placed between a proper build up and follow up, it is highly instructive, too. It is readily arranged by pupils, costs but a few pennies per eruption, and is safe if attention is paid to obvious precautions.

MATERIALS NEEDED

Early in the year a small order can be placed thru the school's purchasing system for the following: one pound of ammonium bichromate (often called dichromate), which costs about 80 cents; one-fourth pound of magnesium powder, which also costs approximately 80 cents; one ounce of magnesium ribbon, which costs about 60 cents. These prices are from a 1952 catalog. Such items cannot be found in a drug store; they must come from a chemical supply house. The above amounts should provide 30 to 40 minor eruptions, or a dozen big ones.

MAKING THE CONE

A few days before the planned eruption, the pupils can mold a volcano cone from clay. Ordinary "yard clay" is preferable to the kind usually purchased for modeling; it costs nothing and requires little work. One foot high and 2 feet across is an impressive size. The cone should rest on a board. The sides of the cone should curve inward like the sides of every natural volcano in the world.

Push a broomstick or similar object down into the cone's tip about 3 inches. Deeper holes may not erupt completely. Remove the broomstick and let the entire cone dry.

MIXING CHEMICALS

Shortly before the planned eruption, pour out on paper the amount of ammonium bichromate that would fill the hole about one and a half times. The crystals should not be ground—the chunky ones work best. Now mix in a little magnesium powder, using a pencil for stirring. It is good policy to stir chemicals carefully; most mixtures like this one are not dangerous, but a few are.

Pour about half the mixture into the hole and save the rest. Push the end of a 3-inch piece of the magnesium ribbon straight down into the middle of the mixture, leaving about an inch of it exposed.

ACTION!

Now we are ready. Set the ribbon afire with a match—and you may have to try a few times. Let the room lights remain on while the class watches you start the demonstration.

Suddenly the magnesium ribbon burns with an intense white flame, leaving a white ribbon of ash. Give the volcano reasonable room now; it will not explode, but faces and hands should not be too near. A steady sputtering will soon start; if it does not, wait a few minutes, insert another piece of ribbon, and light it again.

A fountain of dark green ash will fly upward. More green ash will pour out of the cone and run down the volcano's side. Call it "lava," of course! It is an oxide of chromium and wholly harmless. Sparks of burning magnesium will enliven the fountain of ash.

After a few moments turn out the room lights to make the sparks more of a spectacle. Turn the lights back on soon, for the flow of "lava" is interesting and surprising.

While the sputtering is still lively, pour the remaining portion of the mixture slowly and steadily into the fiery throat, using a spoon. This will prolong the eruption—and the fun. If too much of the mixture goes in at one time, there may be quite a puff, so do not pour from the paper. There is no danger of an explosion, but keep faces and hands at a proper distance.

All eruptions come to an end in due time. When the volcano becomes quiet, the amount of green "lava" will surprise everyone. It should be swept up and thrown away.

The cone may be thrown away, too. Part of the profit of this experiment lies in making a new cone.

KEEP IT SIMPLE

This volcano demonstration was not invented by the writer, altho he first did it decades ago when he discovered what ammonium bichromate would do when heated. It is now described in several publications, but too frequently the demonstration is made complex with a water boiler and tubes for steam, which are not needed for the show. There have been recommendations of "permanent" volcano cones made of plaster, but there is much value in having the children make their own of materials familiar to all.

Pupils may forget many other things that classroom teachers teach them, but they will never forget the lesson on volcanoes.

Experimenting with Air

By WILBERT E. DIEL
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Henry Blow School
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SCIENCE studied in the elementary school should conform to the needs of the children being taught. This is not an age when mere mastery of facts is sufficient. Children must be provided with sensory experiences which make scientific phenomena real and understandable. It is our belief that science in the elementary school should not be limited to one phase of scientific learning, but should incorporate as many fields of science as is possible within the scope of a particular study of a scientific phenomenon.

In teaching a unit on air in the seventh grade at the Henry Blow School, many sensory experiences which involve little or no expense are incorporated. Because only common, everyday materials known to everyone are used, the experiences become a part of the growth, development, and understanding of the child. These experiments make science more real, lasting, and understandable.

A good elementary-school science unit on air might involve only three facts: that air has weight, occupies space, and exerts pressure. These facts of physics can be made real by means of several simple experiments.

AIR HAS WEIGHT

The first problem, to show that air has weight, can be demonstrated by boring a hole in a long stick and balancing it on a rod. Place a deflated balloon on one end of the stick and balance it exactly by sliding a weight along the other end of the stick. When exact balance has been found, remove the balloon and blow it up. Now, hang the inflated balloon at the point on the stick where it was before. The stick will then tilt to the side on which the balloon is placed, showing that the balloon filled with air is heavier than the deflated balloon. This very vividly puts across to the child the concept that air has weight. Any child can do the simple experiment, and it requires easily obtained equipment of negligible expense.

AIR OCCUPIES SPACE

To show that air occupies space, all that is needed is a handkerchief, a drinking glass, and a large glass container such as a fish bowl. The

handkerchief should be placed securely in the bottom of the glass. The glass should be inverted and submerged in the water. When it is entirely under water, scarcely any of the water will enter because the air in the glass occupies the space. When the glass is removed from the water-filled container, the handkerchief can be removed perfectly dry. This experiment makes clear to the pupils in a very tangible way the fact that air occupies space.

AIR EXERTS PRESSURE

The fact that air exerts pressure can be demonstrated by filling an ordinary drinking glass with water and placing a sheet of paper over it. The paper should be held in place while inverting the glass. The hand

The experimental feeding project called for weighing the rats each week.

Phoenix, Arizona Elementary Schools

should be gently removed and the paper will remain in place, holding the water in the glass because of the pressure exerted upon it by the air from the outside.

OTHER PHASES OF SCIENCE

Along with the discussion and simple experiments illustrating these three physical facts about air, many other phases of science can be incorporated. Take, for example, some of the chemical aspects of air like "air contains oxygen." To show this, a shallow jar, a dish, some water, and a candle can be used. Secure the candle to the bottom of the dish and light it. Then fill the dish with water and invert the jar over the candle, the mouth resting on the bottom of the shallow dish. After the flame goes out, the outside air pressure pushes the water up to fill the space formerly occupied by the oxygen which was used up in the burning process.

From the idea that burning consumes oxygen, the fact that the burning of food for energy causes the body to give off carbon dioxide can be incorporated. With a glass tube inserted into a glass containing some clear lime water, carbon dioxide, a product of oxidation, can be detected by having a child blow thru it for a few minutes. The lime water turns milky, at which sight the children always marvel. This is a means of demonstrating that carbon dioxide is given off by the body. From this experiment, the construction of the lung and its function can evolve.

To make the function of the lungs more vivid, some laboratory work can come into play. A sheep's lung can be obtained from a local packing plant by a neighborhood butcher. With this lung the principles of inflation and deflation can be demonstrated by placing a piece of glass tubing into the trachea and securing the trachea tightly around the tube. Then the lung can be inflated by having a child blow into the tube. After it has been inflated, the air can be allowed to escape thru the tube causing the lung to deflate. When this has been done, the lung can be dissected and its component parts examined by the children.

LASTING EXPERIENCES

These are but a few of the many sensory experiences that can be incorporated into such a unit. If the experiments are simple enough, and if the materials involved can be readily obtained, it is desirable to have each child perform all or at least part of the procedure of each experiment. By planning the experiments, bringing in the needed materials, performing the experiments by carrying out the processes involved, and discussing the results, the children obtain understandings of scientific principles that are real, vivid, and lasting.

Henny Penny Teaches First-Grade Science

By NORMAN C. COOPER
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OUR first-graders had been discussing the foods some of them had eaten for breakfast. Eggs held pre-eminence and this led to a discussion of where the eggs had come from. Most of the children could trace them back to the grocery store, but only a few back to the farmer and the chickens.

A MESSAGE TO MIDGIE'S MOTHER

At this point, Midgie informed us that her family had some chickens in their back yard and that one of the hens was "clucky." Naturally, the class didn't know what this meant, so Midgie explained: "The mother hen wants to sit on a nest of eggs and hatch baby chicks!" Someone asked Midgie if she had seen a hen hatch chicks and she hadn't, as her parents had bought the baby chicks from a hatchery. Soon someone else was saying: "Wouldn't it be fun to watch a hen sit on eggs! Could Midgie ask her mother if she might bring the hen to school?" After some discussion, the group decided to write a note to Midgie's mother. That afternoon Midgie proudly carried the message home.

Midgie's mother was very cooperative. She not only brought the hen and plenty of food, but she also went to a great deal of trouble locating and purchasing fertile eggs suitable for hatching (difficult to find in the city!). The hen was a bantam and so much smaller than the average chicken that she could adequately cover only six regular chicken eggs. We placed her in a wire cage which had a nesting box in one end.

WAITING

Then came the days of waiting. We marked them on our calendar and those days were counted over and over before the big day, the 21st, arrived!

In the meantime, the children named the brown bantam, "Henny Penny"—not exactly original but it served the purpose. Henny Penny was watched and cared for by 30 eager, interested boys and girls. She

took all in her stride, remaining completely unruffled and devoted to her nest. (Bantams, fortunately, are very good mothers.) At various stages of the enterprise, the class would compose notes which I wrote on lined newsprint as they dictated. These messages were carried to other classrooms inviting them to come in to see our Henny Penny.

LEARNING ABOUT CHICKENS

During the period of incubation, the days were filled with purposeful activities. Experience stories centering about Henny Penny were written on charts. The more mature children located appropriate stories in books and read them to the group; others brought pictures and information helping to answer such questions as: How does the farmer care for his chickens? Where do they live? What foods do chickens eat? Do chickens have enemies? How do chickens keep warm? How are baby chicks different from grown ones? Do chickens have teeth? How does mother hen care for her chicks? How does she protect them from enemies? Are all chickens alike?

During the project I borrowed a camera with a flash attachment and took pictures of the various activities. These pictures corresponded to many of the children's experience stories, and, when combined with them and reproduced in the form of a book, made interesting reading material, which a third of the group could read easily and accurately without assistance.

DON'T COUNT YOUR CHICKS

"Six eggs, six baby chicks" became the theme song of 30 enthusiastic first-graders. As each day was marked off on the calendar, the days left were counted and recounted. Finally, that most important day of all, the 21st, arrived. Two eggs were pipped on that day and one obligingly hatched before our eyes. "Six eggs, six chicks," sang the children as they left for home that afternoon.

The next morning there were four baby chicks in the nest; two eggs hadn't hatched. Henny Penny sat in the nest all that day and on into the next day, and still the two eggs weren't even pipped. Evidently, they weren't going to hatch. Quickly, the children realized their error; there were six eggs but only four chicks. "Oh, oh!" exclaimed Carol, "Don't count your chicks before they're hatched!"

Studying Jets and Rockets

By WILLIAM S. WEICHERT
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IN THIS day and age one hears much about jet power, especially in connection with aviation. Children and adults are continuously reminded of jet propulsion thru newspaper headlines like: "20 U. S. Saber Jets Battle 80 Russian Migs in Biggest Air Battle of War." Science fiction abounds with stories of jet planes and rockets, especially in reference to space travel. Jet motors have already propelled planes at unheard of speeds and rockets have been driven miles into the upper reaches of the atmosphere. Truly the stories of rockets and jets are fraught with adventurous excitement.

The jet principle is as old as science itself. Its possibilities have been known and experimented with for about 2000 years. Yet it is new. Only within recent years have we recognized the value of jet propulsion for air transportation. Sadly enough, it took a war to stimulate serious, large-scale research in this area. At present, both rockets and jets have their greatest significance as weapons of war. Even the idea of space travel in rockets is pitched in terms of the military advantages that such feats would give the country which first entered space. Be that as it may, there is no doubt that both have tremendous implications for peace as well as war.

THE ACTION-REACTION PRINCIPLE

Books on jets and rockets speak of the jet principle and the rocket principle. Actually, they are basically the same. Both involve what is called the reaction principle. The scientist Newton first stated the principle that *for every action there is an equal and opposite reaction.* This principle can be illustrated simply by an experience most of us have had at one time or another.

Imagine yourself in a rowboat approaching a dock. As you come up alongside the dock, you decide to leap ashore and make the boat fast. You stand at the bow and gage the distance carefully; you leap and land safely on the dock, but as you leaped you felt the boat shoot backward under the push of your "take-off." When you turn to make the boat secure to the dock, you find it floating away out of reach. The thrust of hot gases leaving the jet or rocket under pressure has exactly the same effect.

DISTINCTIONS

The important distinction between rockets and jets is this: The rocket carries a supply of fuel, plus a supply of oxygen in some form. The jet carries fuel but gets its supply of oxygen from the air as the plane passes thru it. A jet, then, is confined to the earth's atmosphere because it must have air for burning the fuel and producing the gases that propel it forward. Theoretically, a rocket would travel better in outer space than it would in the atmosphere because there would be no air resistance.

CAN CHILDREN GRASP THE SUBJECT?

To say that this is all very enlightening but not within the experience of elementary-school children is to play the proverbial ostrich with his head in the sand. One needs only to examine the various learning mediums in the child's world to reject this assumption. Comic books, Sunday and daily comic strips, science fiction, radio, television, movies, and toys all exploit the child's curiosity and love of adventure.

The amount of material available from regular educational sources on rockets and jets is negligible. In addition to being scarce, the material is often presented in a technical and uninteresting manner. Fictional comic books, on the other hand, have taken the imagination of the child into full account. There is a reason for the popularity of these books: children are given plenty of action and adventure in colorful picture-story form.

Commercial and industrial concerns have been quick to realize the comic book potential. Some have published many excellent educational books in this form. These books are usually distributed free and in quantity to classroom teachers.

DEMONSTRATING JET PROPULSION

The propulsive force of a jet motor comes from the hot expanding gases of the burning fuel. These gases are allowed to escape thru nozzles or jets connected to the burning (combustion) chamber. As the gases are under great pressure, they "rush" to escape thru the nozzle opening. As they rush out with explosive force, they "thrust" the plane forward in the same basic way as the leap from our boat forced it thru the water away from us.

The simplest way to illustrate jet propulsion is with a common balloon. Inflate a small balloon. You now have confined a gas in a space under pressure, i.e., the pressure of the air in the balloon is greater than the air pressure outside the balloon. In order to keep the air from rushing out, you must close off the opening thru which you inflated it. The pressure inside the balloon is equal in all directions.

Hold the balloon aloft so that all the children can see. As an alternative, perhaps each child or groups of two or three children could perform the experiment. Hold the inflated balloon closed by pinching the neck between the fingers. Release it and observe its erratic but rapid flight. You have witnessed jet propulsion. The rush of the air from the balloon pushes or thrusts it thru the air in a direction opposite the direction of the escaping air. Finally, when the air pressure within the balloon equals that of the surrounding air, the balloon drops to the floor. If you could keep pumping air into the balloon, it would continue its flight around the room.

The jet plane carries a fuel which is burned when mixed with air and ignited. The hot gases of the burning fuel are the gases under pressure, and, as previously mentioned, a continuous supply of oxygen for supporting the burning is scooped in thru the open mouth of the engine as the plane rushes in its flight.

In jets the faster the gas escapes the greater is the thrust. The larger the opening the faster the gases can escape. However, if the opening is too large and the gas escapes so fast as to rapidly reduce the pressure of gases, there will be no outrush of gases and consequently the amount of thrust will be greatly reduced.

There is on the market, and carried by most 10-cent stores, a small plastic balloon-jet-propelled boat costing about 39 cents. An inflated balloon is attached to a nozzle which allows air to escape in steady, but small, amounts. The escaping air propels the boat thru the water.

A SIMPLE STEAM TURBINE

One of the most common examples of the use of jet power is the steam turbine. A steam turbine is a wheel which has on it a series of nozzles all directed the same way. Steam pressure is built up and released thru the jets. These openings are placed so that the thrust of the steam causes the wheel to move. This motion can be used to do such work as generating electricity.

The idea of using steam for propulsion is one of the oldest applications of the jet principle. Demonstrating the steam turbine is relatively simple. The following experiment can be carried on by most fifth- or sixth-grade children.

Materials Needed

A small pepper tin, some thread, an upright support of some kind, a nail and hammer, some water, and a source of heat.

Procedure

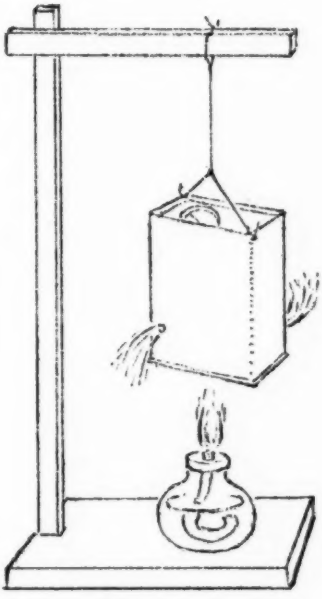
1. Punch holes in two corners of the pepper tin diagonally across from each other. These holes should be placed about one-half inch from bottom and just around the corner on the broad surface of the tin.

2. Pour in about one tablespoon of water and close the opening in the top of the tin.

3. Suspend the tin from the upright support by a looped thread attached to each side of the can (see accompanying diagram). If it is possible to suspend the can by one thread attached to the middle of it, it is desirable to do so. The tin should be in balance and freely suspended.

4. Apply heat (gas burner, alcohol lamp, hot plate, or candle) to the bottom of the can.

When the water begins to boil in the tin and the steam pressure is built up, the steam will escape from the holes with enough force to cause the tin to rotate. (It may be necessary to give it an initial tap to get it started.) If a looped string is used to suspend the can, the whirling motion will soon twist the ends together. This will eventually result in reversing the direction of the spin. The thread may be untwisted and the tin-can-turbine started all over again.



Our Sixth-Grade Weather Station

By BERNARD A. COLE
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PERHAPS the single natural phenomenon which most certainly affects all of our daily lives is the weather. It affects all major areas of human activity and endeavor—food getting, shelter, clothing, communication, transportation, and all of the industries without exception. It has moved governments, determined the destiny of nations, and brought wealth as well as disaster to mankind.

Little wonder then that it has such a strong juvenile appeal, especially in the field of science. It is easily understood; its bare facts, stark and simple. Evidence of the ease with which it is comprehended was readily seen in a sixth-grade class at Stevens School where the children set up a weather station that they might predict changes in the weather.

INTEREST WAS AUTOMATIC

One dull gray morning in January, the skies suddenly opened to release billions of tiny multi-patterned ice particles which floated silently to earth in Washington.

A wave of excitement became immediately apparent in the classroom when little heads obviously began contemplating the many joys that an exciting afternoon in the snow would bring them.

Then Eleanor asked, "What makes it snow?" This led to, "What makes rain, and hail, and the other elements of the weather?" And so, weather, not the classroom teacher, had launched the study and eventual establishment of the weather station.

ATTACKING THE PROBLEMS

Committees were formed to attack the problem. Earl thought it a good idea to find out not only what conditions caused weather changes, but how we could forecast the weather "like the radio announcer does."

So it was that each time a committee found the causes, there was a subcommittee to improvise an instrument to measure the weather condition. There was a milk-bottle barometer capped with sheet rubber with a 2-inch section of drinking straw glued to its center. The outer end of this straw indicated a rising or a falling barometer. The air pressure was duly recorded by the weather charting committee.

University Elementary School, Laramie, Wyoming→

Charles, the big boy, was a busy carpenter, hammering, sawing, and gluing a weather vane, jauntily decorated with the traditional rooster and with an anemometer for measuring the wind's velocity. Ruth and Joshua undertook to measure the humidity of the air, and so constructed a wet-bulb thermometer. Geraldine used an old coffee can to make a rain gage. James painted this instrument white and fixed a scale inside it. James also helped Charles erect our outdoor stand where the instruments could be used without too much interference from buildings and trees which would reduce the efficiency of the readings.

Elizabeth, Mary, and Patricia made a chart for recording the findings. On it were spaces for recording wind direction and velocity, air pressure, humidity, temperature, precipitation, and the like, for each day of the month.

VISITING A WEATHER STATION

During our study of the weather, the class had the opportunity to observe Armed Services Day at Bolling Field Naval Air Station. Fortunately for us, the Air Force had set up a complete weather forecasting station. The children saw weather being plotted on maps, heard interpretations of weather trends in order to give reliable forecasts, and even saw the actual radiosonde which we had studied. It was a large white balloon supporting a tiny radio set used for sending to earth signals indicating the temperature, pressure, and humidity of the upper atmosphere. Totally new to us was the dropsonde which operated to send signals to earth in the same way. The difference was that the helium-filled balloon of the radiosonde carried the radio set up. In the dropsonde a parachute helped the radio set to float gently back to earth after having been released from an airplane.

OUTCOMES

Now "weather fever" runs high in our classroom. Some children are aspirant meteorologists. Many are the plans for weather stations at home. Some have steered their ambitions toward an Air Force commission in meteorology.

The experience was, and remains, a very real, live, and worthwhile one. It has provided strong motives for, and stimulated interest in, the science of weather forecasting and even in the creation of climatic conditions. Most important of all, the children have a greatly expanded understanding of the world in which they live.

Suggestions for Raising Plants

By DWIGHT E. SOLLBERGER
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PLANTS are an important part of the child's world. On his way to and from school the child sees various kinds of plants. Before coming to school he may have eaten a breakfast or lunch which consisted partly of plants. The cotton in his clothing is made from a plant. Houses are constructed largely of plant products, as are chairs, tables, and other pieces of furniture. The school lawn is composed of grasses and other plants which withstand continuous cutting.

In the fall the child observes the beautiful colors of the woodlands. If he lives near a large city, he may have been taken to see a fall "mum" show or its spring counterpart at Easter. When the flowers begin to bloom outdoors in the spring, children may be seen picking violets, dandelions, or other flowers which take their fancy. Truly, motivation should be no problem to the teacher who wishes to "teach plants" to children. It would seem more of a problem to *avoid* dealing with them.

Probably most teachers do teach, or would like to teach, children about the world of plant life. Many schoolrooms have a potted plant or two on the window shelves. The question in the teacher's mind is not, "Should I teach children about plants?" but "How can I teach children about plants?" and "What should I teach about plants?"

GROWING PLANTS IN THE SCHOOLROOM

Children should have many opportunities to grow plants in the classroom or outdoors as the situation permits. Growing plants from seeds, transplanting the seedlings which result, rooting cuttings, and planting bulbs provide excellent activities for the elementary-school child. Such experiences encourage questions, and the teacher will have opportunities to help children learn from firsthand observations. Depending upon the grade level, children may be stimulated to read with the purpose of learning more about growing plants. The directions for growing plants given on the pages which follow should be helpful to the classroom teacher who lacks experience in this field.

STARTING PLANTS FROM SEEDS

When the gardener wants young plants, he grows them in small boxes called seed boxes or flats. After they are well started, they are trans-

planted to pots or to the garden. The following directions will enable one to grow many different kinds of plants from seeds.

Materials Needed

1. A wood seed box about 8 inches x 12 inches x 2½ inches. (The bottom should have holes in it to allow water to escape.)
2. A mixture of one part each of sifted sand, sifted garden soil, and sifted humus
3. A block of wood for tamping the soil in the box
4. Seeds
5. Newspapers
6. Glass cover of same size as seed box
7. Small pebbles
8. Water sprinkler.

Procedure

1. Cover the bottom of the seed box with two thicknesses of newspapers and about one-half inch of pebbles.
2. Fill the seed box to overflowing with the soil mixture and level it off to the top edge of the box by scraping off the excess soil with a straight-edge board.
3. Tamp the soil down tightly until it is one-half inch below the level of the top of the box.
4. Moisten the soil thoroly with the sprinkler.
5. Plant the seeds in straight grooves made with a corner of a block of wood. Cover the seeds to a depth of about twice their width.
6. Tamp the soil tightly over the seeds. The soil mixture will not cake.
7. Place the glass cover over the box and place the box where the temperature ranges between 65 and 75 degrees.
8. Remove the glass cover as the young plants grow up to it. Keep the soil moist but not soaked. If water forms on the under side of the glass, the soil is wet enough.
9. Transplant the young plants after they have developed two or three leaves in addition to the leaves that pushed thru the soil from the seed.

TRANSPLANTING PLANTS

Transplanting young plants from a seed box injures the roots. Since the plant must have water, it is important to see that the plant is well watered before being transplanted and as little injury as possible is done to the roots in the process. After transplanting, the plant may need protection from drying out until the root injury has been repaired by new growth.

Materials Needed

1. A number of 3-inch clay flower pots
2. A seed box containing the plants to be transplanted
3. A water sprinkler

4. A soil mixture of one part sifted sand, one part sifted humus, and one part sifted garden soil
5. A flat stick or putty knife with which to lift the plants.

Procedure

1. Water the plants in the seed box at least two hours before transplanting.
2. Partially fill the flower pots with the soil mixture and moisten thoroly.
3. Cut the soil in the seed box with the stick and lift out the plants with a ball of soil on the roots if possible.
4. Place the plant in the flower pot and firm the soil around it. Fill the pot to within one-fourth inch of the top.
5. Water the plant thoroly and place it where it will have adequate sunlight. If the pot is placed in a saucer designed for holding flower pots, moisture from the pot will not mar the woodwork.
6. From time to time it is necessary to move the plant to a larger pot. By turning the plant upside down and tapping the edge of the pot on a table, the plant and the entire ball of soil will come out. When the roots reach the outside of the ball of soil, it is time to transplant.

GROWING BULBS

In order to produce the best flowers, bulbs should be grown in good soil like other plants. The expert tries to develop a sturdy root system before allowing the flowers to develop. The following procedure should enable the children and teacher to bring bulbs to flower successfully.

Materials Needed

1. Some bulbs of tulips, hyacinths, narcissus, or daffodils. (Large, well-formed bulbs should be selected.)
2. Several 5-inch clay flower pots with saucers
3. Soil mixture consisting of two parts good garden soil and one part well-rotted humus
4. A cup of bone meal
5. One-quarter teaspoon measure.

Procedure

1. Fill a flower pot two-thirds full with the soil and mix in one-quarter teaspoon of bone meal.
2. Press three to five bulbs, depending on their size, into the soil. The top of the bulb should extend slightly above the rim of the pot. Fill the space around the bulbs until the pot is filled to within one-fourth inch of the top.
3. Water the bulbs thoroly and place them in a cold cellar, where the temperature stays close to 40 degrees, to produce roots. If this is not possible, place them in a cold frame and cover them with leaves to prevent freezing. They may be buried in the ground and covered with a mulch of leaves. Keep the bulbs moist but not saturated.
4. After eight to 10 weeks at this temperature, place the pot in a warmer place of approximately 50 degrees. At this temperature the leaves should develop slowly.

5. After the leaves have developed, bring the plants to room temperature and allow them to come to bloom. Temperatures as high as 80 degrees may be harmful to the bloom.

In the classroom situation, it may be impossible to carry out the above routine or even to approximate such a schedule. The teacher may consult a local greenhouse for advice or help. Students may be able to store the bulbs at the proper temperatures and bring the potted plants to school for the final stages. If all else fails, the teacher may simply put the bulbs in the pot as described and let the flowers come along as best they can. They will usually bloom, but the blooms will not be as attractive as they should be.

GERMINATING SEEDS

Seeds need moisture, air, and moderate heat in order to start to grow. Man stores seeds by denying them moisture, and starts them growing by supplying them with moisture.

Materials Needed

1. A large metal tray or cookie tin
2. Paper towels
3. Seeds of various kinds. (Ordinary vegetable seeds such as beans, radish, corn, and tomato will serve.)

Procedure

1. Spread enough paper towels over the bottom of the tray to hold moisture for several days.
2. Spread the seeds over the paper towels. If exactly 100 seeds are used, percentages of germination may be computed more easily.
3. Cover the seeds with several layers of paper towels and moisten the towels thoroly.
4. Press the towels down firmly. A board, a piece of glass, or another tray may be used to cover the germinator to prevent undue loss of water by evaporation.
5. Place the tray on a shelf for three or four days at room temperature. Examine as needed to observe germination, always being sure to keep toweling moist.

GROWING PLANTS FROM CUTTINGS

Gardeners often start new plants from pieces of other plants. These are called cuttings. Cuttings may be a piece of a stem, a leaf, or a root. In order to continue to grow, such pieces must develop roots. Some plants produce roots much more easily than others, but most plants will produce roots under certain conditions. The directions that follow should enable the classroom teacher and children to root some cuttings successfully.

Materials Needed

1. Some well-developed geranium or coleus plants with many branches
2. Several 3-inch flower pots, one for each cutting
3. A mixture of one part each of clean sand and peat moss
4. A knife for cutting the plant and a water sprinkler.

Procedure

1. Fill a flower pot with the sand and peat mixture to within one-fourth inch of the top.
2. From a healthy shoot of a geranium plant, cut a piece which bears three leaves spaced about one inch apart.
3. Remove the lowest leaf and place the cutting in the sand and peat mixture half way to the second leaf.
4. Water the cutting thoroly and place it in moderate sunlight. Keep it moist at all times. This may be aided by placing the pot containing the cutting in a much larger pot containing sand. The larger reservoir will help to maintain a uniform supply of moisture.
5. After the cutting has developed roots, it may be transplanted to a pot containing soil composed of equal parts of sifted sand, garden soil, and humus.

OTHER ACTIVITIES

Trips outdoors should be used freely to help children learn about plants. The plant in its natural setting is a most effective device for teaching children about plants. Limiting the learning to the classroom makes hard work of what could be easy.

Children may be taken outdoors to see the many different kinds of plants that grow near their homes. They can see the kind of lawn that grows under shade trees, on good soil, and on the fill soil of a house just built. They can see that different kinds of plants grow in lawns, in fields, in woods, in swamps, and on steep hillsides. A weedy garden is a good place to learn how some plants can be troublesome. A visit to a farm will provide many opportunities to learn about food plants and how plants and animals are related to each other. How plants disperse their seeds, the relationships between plants and insects, and the parts of plants—all may be studied in a natural setting where materials are abundant. A trip to a greenhouse or conservatory will show that many people appreciate the beauty of plants.

Experimenting with Plants

Plants are slow to react to varying conditions of growth, and children like to see things happen quickly. For this reason experiments with plants may not arouse as much interest as experiments with physical

apparatus. Children should be encouraged, however, to suggest experiments which will give answers to questions which arise in and out of class. Growing plants with and without water, with and without sunlight, and in different kinds of soil are examples of simple experiments which children may do with good results. Demonstrations may be set up by the teacher or children. Showing that water goes up the stems of plants, that roots grow down, that stems grow toward light, that seeds germinate between moist blotters, and that leaves give off water will help the children understand important facts about plant life.

Identifying Plants

Teachers are sometimes puzzled about what they should do with the problem of identifying plants. Perhaps some enthusiastic gardener or college professor has impressed the teacher with the multitudinous plants one might know. As in other fields, there is some specialized knowledge that the classroom teacher should have. Teachers need to know the names of many plants. On the other hand, the elementary-school teacher cannot be expected to answer all the questions that all the children ask about plants.

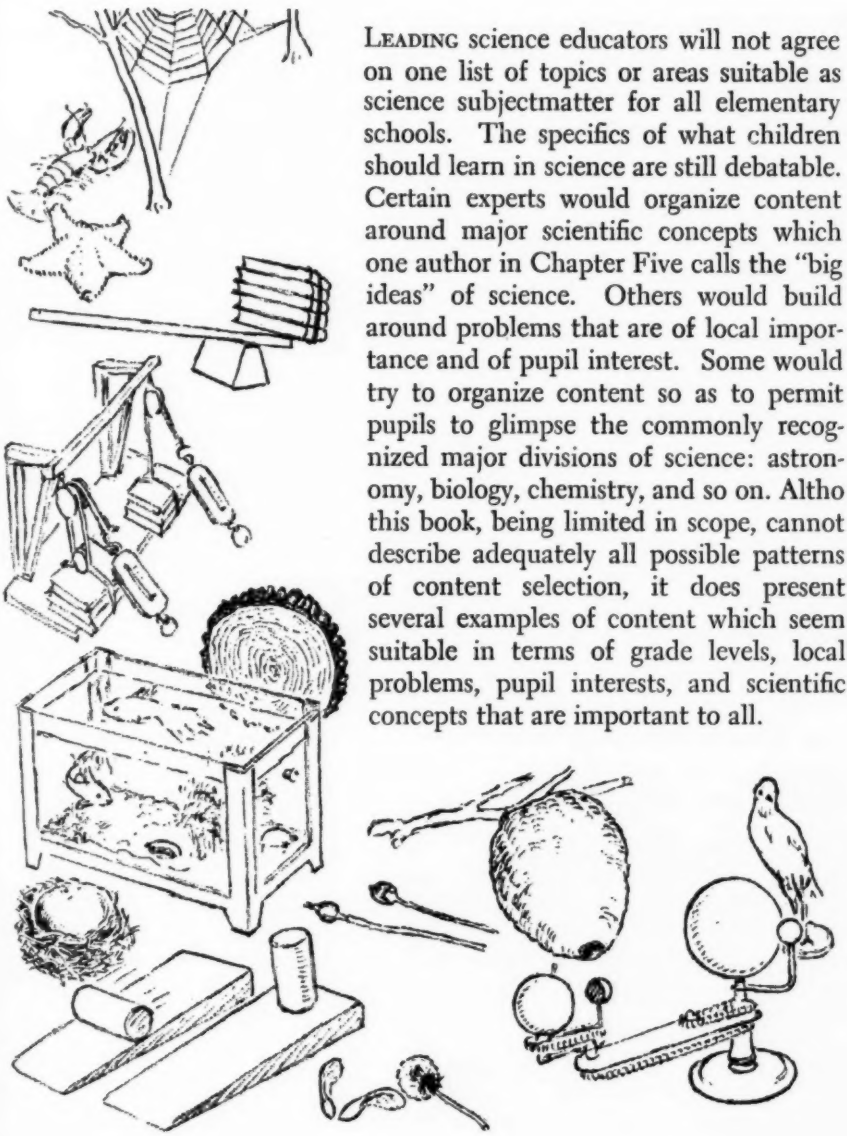
Children should learn the names of the plants they encounter in their surroundings or in their schoolwork. Teachers usually know the names of many of the common plants which they have met in one way or another. Common names of plants should be sufficient, altho children will accept the scientific name if there is a good reason for using it, and the teacher might do likewise. There is an increasing number of books on the market which contain pictures useful to the classroom teacher who is seeking the name of a plant. In most communities there are individuals who are greatly interested in plants and who would be able to identify plants for the teacher.

Learning Plant Structure

The structures that children need to know are the gross structures which they can see with the unaided eye, or at most with a magnifying glass. The child can see a root, stem, leaf, leafstalk, flower, fruit, seed, and bud. It is necessary to take up some of the parts of a flower in order to explain how seeds are produced. The microscopic cross sections, necessary to complete understanding of plant structures, do not belong in the elementary school. A visit to a garden would uncover many interesting variations of the above structures such as potatoes (stems), carrots and beets (roots), broccoli (flowers), brussel sprouts (buds), cauliflower (flowers), and others.

CHAPTER FOUR

Elementary-School Science Content



LEADING science educators will not agree on one list of topics or areas suitable as science subjectmatter for all elementary schools. The specifics of what children should learn in science are still debatable. Certain experts would organize content around major scientific concepts which one author in Chapter Five calls the "big ideas" of science. Others would build around problems that are of local importance and of pupil interest. Some would try to organize content so as to permit pupils to glimpse the commonly recognized major divisions of science: astronomy, biology, chemistry, and so on. Altho this book, being limited in scope, cannot describe adequately all possible patterns of content selection, it does present several examples of content which seem suitable in terms of grade levels, local problems, pupil interests, and scientific concepts that are important to all.

Conservation of Human Resources

By ANNE BLASIC
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WHILE planning a unit based on the resources of the Rio Grande Valley, a fifth-grade class reached the conclusion that of all its resources the people who live there are the most important. A discussion of the health problems revealed a major concern over poliomyelitis which had reached epidemic proportions in this region during the past three years.

This semitropical region leads the nation in the number of cases of tuberculosis and dysentery, and infections of various kinds are prevalent.

Instead of being afraid of polio and other diseases, the class decided to find out how to conserve health. By means of teacher-pupil planning a unit based on personal and community health evolved. It was called, "Conservation of Human Resources."

Before the unit was planned, the classroom teacher did some preliminary work on basic objectives, materials, and possible resources. Pictures on the bulletin board, health books in the library corner, and a glass jar of mosquito larvae in the science corner helped to awaken interest.

OBJECTIVES

With science as the core, this integrated unit included language arts, arithmetic, and creative arts. The general objectives of the teacher were:

1. To teach children to conserve and improve their own health, and thus be more able to secure that abundant vigor and vitality which are the foundation for the greatest possible happiness and service in personal, family, and community life
2. To promote satisfactory understandings, attitudes, and ways of behaving in order to improve and maintain health in the home and in the community
3. To overcome superstitions and prejudices
4. To provide experiences in healthful living
5. To seek and make use of scientific information
6. To develop appreciation of the scientists whose discoveries have improved health.

The specific objectives that developed thru the process of teacher-pupil planning were:

1. To understand the importance of personal cleanliness
2. To appreciate the value of foods for good health
3. To learn how diseases are spread
4. To know the importance of a clean community.

OUTLINE OF WORK

The following outline shows how the above named objectives were made meaningful to the children.

1. The importance of personal cleanliness—How cleanliness keeps me well
   a. Core ideas
      (1) Baths should be taken regularly
      (2) Hands should be washed before eating
      (3) Hands should be washed after using the toilet
      (4) Hair, nails, skin, and teeth should receive proper care
      (5) Clothes should be kept clean and in good condition
      (6) Foreign objects should be kept out of the mouth
   b. Experiences
      (1) Learned the value of having one's own towel and wash cloth
      (2) Listed the things needed for a good bath
      (3) Demonstrated the proper way to wash and dry hands
      (4) Pupils looked at their skin thru a magnifying glass
      (5) Discussed what should be done to prevent the spread of skin and scalp diseases
      (6) Prepared slides of skin diseases found in school. Used microscope
      (7) Discussed how to care for the hair
      (8) Examined human hair under a microscope
      (9) Discussed why chewing fingernails and putting fingers into the mouth are not sanitary
      (10) Discussed why clean clothes should be worn and why we should not wear other people's clothes
      (11) Experiment: made soap and discussed how clean hands prevent diseases
      (12) Kept a weekly health chart. The chart was made at school; however, the record was kept at home and brought to school on Fridays for checking
      (13) Committee placed pictures on bulletin board illustrating various phases of health, such as beautiful skin, well groomed hair, clean nails, clean teeth, and clean hands
2. Value of foods to good health—How foods keep me well
   a. Core ideas
      (1) Foods are needed to produce heat and energy, to supply re-

pair material and growth material, and to supply regulatory material
(2) Different kinds of foods serve different purposes
(3) Everyone needs a balanced diet
(4) Eating breakfast is important
(5) Milk is needed in the diet
(6) Vitamins are valuable
(7) Fruits and vegetables should be washed before being eaten

b. Experiences

(1) Kept a food record for a week
(2) Experimented with the feeding of white rats: one group was fed candy and soda water; the other a balanced diet
(3) Pupils who grew vegetables or citrus fruits at home brought them to school. They did research on the values of each product and made group reports
(4) Discussed why fruits and vegetables should be washed and how this procedure prevents diseases

3. Balance of exercise and rest—How exercise and rest keep me well

a. Core ideas

(1) Exercise makes the organs of the body work more efficiently
(2) Enough sleep and a regular time to go to bed are necessary for good health
(3) Restful sleep requires certain conditions
(4) There is a relationship between sleep and growth
(5) One should know when and how to rest
(6) Rest helps the heart

b. Experiences

(1) The separate benefits of exercise and play were discussed
(2) Proper forms of exercise were demonstrated on the playground
(3) The captain of the high-school football team was asked to talk to the group. He discussed the value of proper diet and rest
(4) Kept a sleeping chart for one week
(5) The value of fresh air was discussed. This included experiments with oxygen
(6) The importance of proper posture and its relation to health was discussed
(7) The value of resting before and after eating was considered
(8) Discussed the danger of opening windows when pupils come in hot and perspiring after the play period
(9) Discussed the danger of too strenuous exercise during hot weather. This is one way to avoid polio
(10) Discussed the danger of drinking ice water when one is too hot. Experimented with ice water to show what happens to the outside of the glass after ice water stands in it for awhile

4. Diseases—What can I do to keep well?
   a. Core ideas
      (1) One's mouth should be covered when coughing or sneezing
      (2) Sores should be kept bandaged
      (3) Milk should be pasteurized
      (4) One should drink only publicly inspected and approved water
      (5) The value of vaccination and inoculation should be known

   b. Experiences
      (1) Pupils were asked to bring a clean handkerchief or Kleenex to school each day and to cover mouth while coughing and sneezing
      (2) Each pupil held his own mirror in front of his mouth. Moisture on the mirror was revealed. Then we talked about how germs are spread
      (3) Identified the sources of milk supply
         (a) Pasteurized a small quantity of milk
         (b) Tested samples of milk for dirt by filtering it thru absorbent cotton
      (4) Read about Pasteur
      (5) Discussed how germs may be carried into the body from dirty hands
      (6) Discussed why boys and girls should not swim in irrigation canals
      (7) Experiment: showed filth of canal water by placing a sample of it under a microscope. Removed mud from water by filtering it thru sand

The school garden can be a valuable science laboratory.

Phoenix Elementary Schools, Phoenix, Arizona

(8) Discussed vaccination and showed a film dealing with smallpox vaccination
(9) A committee studied ways of preventing the breeding of flies
(10) One committee did research on the mosquito; another on fleas usually found on mice, rats, and cats
(11) Discussed the disadvantages of community showers, kitchens, and toilet facilities which are usually found in trailer camps

5. How diseases are spread—How can I avoid catching a disease?

a. Core ideas

(1) Bacteria are spread in many ways
(2) There are proper ways of caring for colds, sore throats, and coughs
(3) There is a right way to dress for rainy weather
(4) We should keep away from people who cough or sneeze
(5) It is important to keep pencils and other objects out of the mouth
(6) Diseases are communicable

b. Experiences

(1) Discussed helpful and harmful bacteria. A committee reported on where bacteria come from, how they grow, and what diseases are caused by bacteria
(2) Talked about ways to prevent colds
(3) Found out how harmful bacteria get into drinking water
(4) Discussed methods of treating colds
(5) A committee of girls dressed a doll for a rainy day
(6) Discussed why we should keep foreign objects out of the mouth
(7) Reviewed the reasons why we should keep our hands clean

6. The importance of community health—How can I contribute to the health of others?

a. Core ideas

(1) Yards and alleys should be kept clean
(2) The school grounds should be clean
(3) Streets, parks, and other public places should be kept clean
(4) Only stores and eating places that are clean should be patronized
(5) It is important to know how the city disposes of waste
(6) We should know what the city does to prevent the spread of disease
(7) All children should know how to care for pets

b. Experiences

(1) Brought pictures of attractive, well-kept yards for the bulletin board
(2) Discussed and listed ways of keeping a yard and alley clean
(3) Formed committees for the purpose of actually keeping individual yards clean. Later each individual in each group made a report. Took pictures before and after cleaning up yards

(4) Discussed why citrus fruit and banana peelings should not be thrown on the school grounds or anywhere else
(5) The class selected an inspection committee to see that the playground was kept clean during the physical education period. Committee membership changed from month to month
(6) Discussed the benefits of trash cans on the streets and in parks for waste paper, which, incidentally, includes wrappers of candy bars and chewing gum
(7) Discussed how diseases are spread by spitting on streets and in public places. Tuberculosis especially is spread in this manner
(8) Found out what sanitation regulations stores and eating places must observe
(9) Compared old methods of handling foods with modern methods
  (a) Sanitary-packed vegetables
  (b) Frozen foods
(10) Discussed how the city disposes of garbage, trash, and human waste. Is the sewage disposal plant adequate? How do outdoor toilets endanger the lives of the citizens of the community and of the Rio Grande Valley? Do they help polio to spread?
(11) Discussed what the government does to prevent disease
  (a) Functions of the city, county, and state health departments
  (b) Why is the city sprayed from time to time with DDT?
(12) Discussed the proper care, feeding, and bathing of pets, and proper sleeping quarters for pets
(13) Discussed the inoculation of dogs to prevent rabies
(14) Discussed how pets help diseases to spread. (In one city in the Rio Grande Valley there were cases of typhus traced to baby kittens given away by one child.)

CULMINATING ACTIVITIES

A radio program, "How To Prevent Polio," was given over the local radio station during the March of Dimes week. A visiting day was held during which children acted as hosts and hostesses to show and explain their charts and work to parents.

The unit lasted six weeks; however, we worked toward the objectives thruout the entire year. This unit may be much broader than outlined herein; it actually has no limits. Groups of children may do more intensive and extensive research on various phases of study. The number of activities is limitless, depending on the energy and ingenuity of pupils and classroom teacher.

A Fifth- or Sixth-Grade Unit on the Sun

By NORMAN C. COOPER
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THE sun is a subject unusually well suited to the interests of 10- and 11-year-old boys and girls. The following unit of instruction illustrates how this challenging subject can be taught in fifth- and sixth-grade classrooms.

UNIT THEME

The sun is the center of the solar system around which all other members of the system revolve.

UNIT CONCEPT

The sun is very large.

OBJECTIVES

Forty-nine worthy aims and objectives are identified in this section under the general headings "Knowledge," "Attitudes," "Skills," "Habits," "Wholesome Interests," "Scientific Attitude," and "Appreciation." Each is well worth pursuing in elementary-school science.

Knowledge

1. The sun is a star
2. The sun is just one of many stars in the heavens
3. The sun, while very large, is one of the smaller stars
4. The sun is an enormous body
5. The sun is far away
6. The sun has satellites
7. The sun is the center of the solar system
8. The sun is very old
9. The sun is hot
10. The sun has spots

Attitudes

1. Astrology is not a science; astronomy is
2. The sun will not get close enough to the earth to burn us
3. The sun is our benefactor
4. We could not exist without the sun
5. We can experiment to find out things about the sun
6. The scientific method enables us to learn many things about the sun

Skills

1. Develop ability to read longer and more complex stories about the sun
2. Learn to use the right words in talking about the sun
3. Learn to spell correctly the words in the vocabulary
4. Develop the ability to express one's thoughts clearly when writing about the sun
5. Develop ability to think and speak clearly about the sun in quantitative terms
6. Develop ability to express one's self thru art in case we wish to draw illustrations or make a mural showing the sun and its relation to its satellites
7. Develop ability in abstract thinking in order to visualize space and the position of the sun in space
8. Develop ability to talk intelligently about the sun before members of the class and among grown-ups

Habits

1. Develop habits of reading beneficial and worthwhile literature
2. Develop good work habits
3. Develop habits of being a good committeeman
4. Develop habits of being a good research worker
5. Develop habits of reliability and accuracy
6. Develop the habit of sticking to a task until it is finished
7. Develop the habit of being a good speller
8. Develop the habit of, and taste for, writing good compositions
9. Develop the habit of being an original thinker

Wholesome Interests

1. Interest in astronomy
2. Interest in telling the time of day by the sun
3. Interest in sundials
4. Interest in developing astronomy as a hobby
5. Interest in estimating space
6. Interest in utilization of sun's light by plants and animals

Scientific Attitude

1. Pupil becomes more curious about the sun
2. Pupil sees that sun spots have a natural cause
3. Pupil keeps an open mind about theories of astronomers
4. Pupil respects other people's points of view about the sun
5. Pupil becomes determined not to believe in superstitions about the sun
6. Pupil is persistent in his search for truth about the sun

Appreciation

1. Appreciation of man's place in nature as a beneficiary of heat and light from the sun
2. Appreciation of the orderliness of the universe
3. Appreciation of the harmony of the laws of nature
4. Appreciation of the significance of the sun's energy

MAJOR PROBLEMS

1. What is a star?
2. Why is the sun classed as a star?
3. How many neighbor stars does the sun have?
4. Is the sun a large or small star?
5. How large is the sun?
6. How far away is the sun?
7. What are the sun's satellites?
8. Why is the sun the center of the solar system?
9. How old is the sun?
10. How hot is the sun?
11. What are sun spots?
12. Does the sun shine only during the day?
13. Will the sun's heat ever die out?
14. Will the sun ever lose its grip on its satellites?
15. Will the sun ever fall out of the sky?

PUPIL ACTIVITIES

1. Search the reference books for information on the above problems
2. Work in committees to come to some definite conclusions about the above problems
3. Conduct experiments
   a. Weigh a pound of bb-shot and count the shots. With one bb-shot representing the earth, show how many earths it would take to fill the sun if it were hollow
   b. Have one pupil represent the sun; the others, the satellites. Let them go out onto the playground and place themselves in relative positions (allowing for distance) as members of the solar system
   c. With chalk or lime make a circle on the school ground with a diameter of 109 feet to represent the sun. Make a small circle one foot in diameter to represent the earth. This shows the relative sizes of the sun and earth
4. Draw a mural of the sun and its satellites
5. Construct a sundial
6. Practice the vocabulary words selected by the vocabulary committee
7. Practice the spelling words selected by the spelling committee
8. Write a theme on one of the following subjects:
   a. Sun Spots
   b. Temperature of the Sun
   c. Size of the Sun
   d. The Sun and Its Satellites
   e. The Sun as a Star
   f. Age of the Sun
9. Observe good penmanship in writing the theme and practice penmanship in writing the spelling words
10. Meet as a group or class to discuss the findings and conclusions of the various committees

TEACHER ACTIVITIES

1. Give an informal talk about astronomy and the solar system to help orient the children
2. Show clippings from the teacher's file on the sun
3. Show a photograph of sun spots
4. Show a picture of an observatory
5. Show pictures of the sun from various books on astronomy
6. Show the movie, *What Makes Day and Night*[1]
7. Show work that former students did on similar projects

MATERIALS

1. If one is available, a globe of the world to use as the sun. (If a globe is not available, a basketball will serve equally well.)
2. Marbles to use as satellites
3. Bb-shot
4. Flashlight to show sun's rays
5. Plain, light wrapping paper for murals
6. Chalk or lime dust
7. Placards for children to be used to identify the sun and its satellites
8. Yardstick and a 25- to 50-foot cord

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[1] *What Makes Day and Night*. 16 mm, sound, 8 min. Young America Films, 18 East 41st St., New York 17, N. Y., 1947.

Science offers a wonderful opportunity for developing rich and varied interests. To engage children absorbingly in growing a few plants, rearing animals, observing and exploring, collecting, experimenting, reading, and writing their experiences is to open to them avenues of interest and satisfaction which lead farther into the realm of self-realization than the teacher can vision.

—W. C. CROXTON, *Science in the Elementary School*, McGraw-Hill Book Co., 1937.

Studying Weather in the First Grade

By GRACE P. GIST
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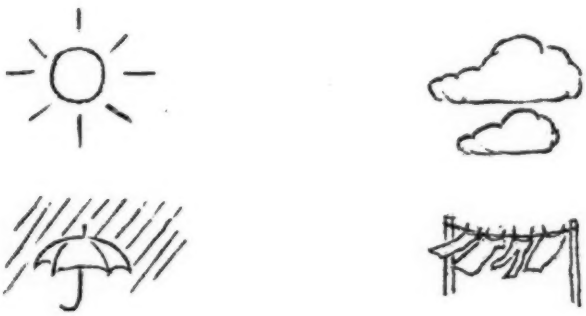
A RAINY day presented a fine opportunity to introduce a unit on weather to our first-grade class. A discussion of rain drew attention to the ways in which weather changes. We talked about sunshine, rain, snow, clouds, and winds. The classroom teacher suggested that it might be interesting to keep a record of the weather. The children became enthusiastic and decided to start a weather calendar for the month of January, using the following symbols:



PREPARATION

In preparation for our study, the children were asked to search for pictures illustrating various kinds of weather. These, along with others contributed by the teacher, were displayed, and considerable discussion followed. The class talked about sunny-day activities, rainy-day activities, and things that could be done on a windy day. We also discussed the best ways to dress for each kind of weather.

ACTIVITIES

The following day we decided to write about our discussion of weather, and the children composed the following statements: "There are many kinds of weather. We have rain, sunshine, wind, and snow. Sometimes it is hot and sometimes it is cold."

The teacher made a large weather calendar with a space for each day in the month of January. The children were given hectographed copies of the calendar on which they kept a daily record of the weather for the entire month. Each morning the class decided which symbol would represent the weather for that day, and each child would check his calendar accordingly. The teacher would make the recordings on the class calendar.

Many other activities contributed to a better understanding of our unit. One was the drawing of pictures showing the weather each day. One child was always permitted to do this with finger paints. While most class members kept themselves busy drawing at their seats, a few children worked on a mural at the board using colored chalk. Such work called for close supervision and much help from the teacher; however, the children were so interested in what they were doing that their efforts resulted in unusually fine art work for first-graders.

Each morning our experience story developed as a result of our observation of weather for that day. After free discussion of the weather, the children would make up stories like:

It is raining today. See the dark clouds in the sky. They are rain clouds. Rain comes from the clouds.

The rain is over. The sun is now shining. See the rainbow in the sky. The rainbow comes after the rain.

The writing of our experience stories constituted the major part of the handwriting experience in the unit. The stories of many of the children were displayed along with the mural and other drawings of weather. Among other stories composed were:

See the sun. The sun is shining. The sun is in the sky.

Today is a cloudy day. There are many white clouds in the sky, but they are not rain clouds.

The wind blows. It blows the clouds in the sky. It blows kites and clothes too.

The study of the rainbow came as a result of our discussion of rain. Because most of the children had seen a rainbow, the teacher felt that the rainbow should be considered. We secured a glass prism and each child was given an opportunity to observe the colors in their proper sequence.

The study of snow was presented vicariously thru books and pictures which we had on hand in our classroom library and thru the experiences of those few children who had seen snow. However, the children followed up their study with story writing and drawings in much the same manner as when studying other elements of weather. Other activities

to further our interest in weather included observations, excursions, demonstrations, and experiments.

ACTIVITY CARDS

The teacher made activity cards, color-coded according to the following subjects:

Weather

Draw a picture to show what kind of weather it is today.

Clouds

Breathe on a window pane. Note the pane "clouds" with moisture.

Rainbows

Let sun shine thru a prism. This is the way the sun shines thru raindrops and forms a rainbow.

Cold and Hot

1. Watch a thermometer to see the red line move down when weather is cold and up when it is hot.
2. Fill a jar full of water. Cap it tightly and place it on the window ledge. When the water freezes, what happens to the jar?

Wind

Go for a walk and look for signs: the wind blowing leaves, clothes blowing on a line, the wind in our faces as we walk. Make paper pinwheels and let the wind turn them.

WATER THAT WOULD NOT FREEZE

All the above activities were carried out after a careful explanation of the purpose for which the activity was presented. In learning about hot and cold weather, the children learned to read the thermometer. One very cold day our thermometer outside read 20 degrees. It was on this day, following an explanation of the word "freezing" as 32 degrees on our thermometer, that we decided to carry out the experiment listed under the study of "Cold and Hot." The children wrote the following observations and conclusions.

Friday, February 2, 1951—Our thermometer outside read 20 degrees. We filled a jar with water. We capped it tightly and placed it outside the window. The water did not freeze. It had become warmer. The thermometer showed 40 degrees when we brought the jar inside.

EVALUATION

The following simple concepts were developed among these first-grade children:

1. We have many kinds of weather.
2. Sunshine, rain, wind, and snow are kinds of weather.
3. By observing clouds and wind we can often predict the weather.
4. Our activities vary with the weather.
5. We choose our clothes according to the weather.
6. There is water in the air.
7. Clouds are moisture in the air.
8. A thermometer shows us how hot or cold it is.
9. The sun gives us light even on cloudy days.
10. Wind is moving air.

SUBJECT INTEGRATION

Our experience stories and experiments presented much material for handwriting lessons. Here we studied letter formation, spacing, and other writing skills. The number of excellent papers placed on display was an indication that writing skills developed during our unit of study.

The science vocabulary introduced during the unit included such words as:

blow	clouds	shining
rain	warm	weather
rainbow	cloudy	freeze
sky	cold	dark
sun	hot	white
sunshine	wind	shadows

The repeated use of the words, both in discussion and in writing, made it possible for the children to acquire these words as a part of their reading, speaking, and writing vocabulary.

The use of the numbers 1 thru 31 as dates on our calendar gave children some understanding of the number system. They acquired the knowledge that there are seven days in a week and four weeks in a month; that there were more days of sunshine than rain during the month of January.

As pointed out previously, there were many opportunities for creative art work thruout the entire unit.

The alternative to omitting, reducing, or failing to improve and increase science education is to deny the achievements and impact made by science in modern living. He who reads may run, but he who does not read* must *run.

—*Science Education in American Schools*, Forty-Sixth Yearbook, Part I, National Society for the Study of Education.

Studying Nuclear Energy in the Seventh and Eighth Grades

By EMILIE LEPTHIEN

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THE recent atomic weapon tests in Nevada greatly interested the pupils in the seventh- and eighth-grade science classes at Belding school. The topic was discussed in the social studies current events periods, but the pupils wanted more information regarding the why and how of atomic energy, or "nuclear energy" as we soon called it.

Our first step was to learn that the earth is composed of less than 100 known elements; that these elements may be combined in compounds and mixtures which again may be separated into the elements in the chemical laboratory.

PROVING THAT ELEMENTS EXIST

Simple experiments were performed to prove the existence of elements. Mercuric oxide was heated, the oxygen liberated, and a residue of mercury was left inside the test tube. The test for oxygen was made by inserting a glowing splinter into the test tube and observing that it burst into flame.

Litmus paper tests were made for acids and bases. Tests for starch were made with various foods and iodine.

ANALYZING THE ELEMENTS

By following the charts of the elements, an exhibit of examples of the elements was made. The exhibit was limited but interesting.

We began to learn that each element has a symbol which represents it in formulas, and soon we began to read some of the simple formulas.

Several children inquired about the numbers which appeared on the charts along with the names and symbols of the elements. We were ready to begin our study of the atom, learning that an atom is the smallest possible particle of an element.

We learned that the nucleus of the atom contains protons and neutrons and that in the orbits surrounding the nucleus are varying numbers of electrons. The numbers of these charges determine the nature of the element. The number of protons determines the atomic number of the atom or the element. The combined number of protons and

neutrons corresponds closely to the atomic weight since the weight of the electrons is almost negligible.

Found with the atoms of many elements are isotopes, atoms which contain the same number of protons in the nucleus but a different number of neutrons. Thus their atomic weight is different from the regular atomic weight of the element.

RADIO-ACTIVE ELEMENTS

Some elements have atoms which remain stable, but a few elements are radio-active—that is, they give off energy by radiation and change into other elements. Uranium, which is radio-active, undergoes many changes thru radium down to lead.

Using this knowledge of radio-active elements and the knowledge of isotopes, scientists discovered that uranium, a radio-active element, had an isotope U_{235} which could be split when the nucleus is hit by a slowly moving neutron. This releases more neutrons which strike other U_{235} nuclei and a chain reaction takes place. This fission, or splitting, releases a great amount of energy—energy which can be used for constructive as well as destructive purposes.

THE ATOMIC PILE

This fission or chain reaction has been conducted in an atomic pile or atomic furnace where the chain reaction can be controlled. Heat and energy are released in the atomic furnace as they are in the coal furnace.

Having found that the energy which is released comes from the nucleus of the atom, the term "nuclear energy" was readily understood by the students.

Using an inexpensive spinthariscope which contained a minute portion of radium, natural transmutation or the emission of alpha particles from the atoms could be observed.

USING FILMS

The class used the films *A Tale of Two Cities*[1] and *Operation Crossroads*[2] to observe the destructive power of atomic bombs. *Atomic Energy*[3] was also shown to review what we had learned about fission and chain reactions.

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[1] *A Tale of Two Cities.* 16 mm, sound, 12 min. Government Films Dept., United World Films, 1445 Park Ave., New York 29, N. Y., 1946.

[2] *Operation Crossroads.* 16 mm, sound, 26 min. Government Films Dept., United World Films, 1445 Park Ave., New York 29, N. Y., 1949.

[3] *Atomic Energy.* 16 mm, sound, 11 min. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill., 1947.

A question about the difference between the atomic bomb and the H bomb immediately arose. Fusion as evidenced by the source of the sun's heat and energy was compared with fission. We learned that this fusion releases tremendous energy and heat.

Having learned of the destructive power of the atomic bomb, the ability to promote the welfare of mankind thru nuclear research was discussed. For this purpose we used the film *Report on the Atom.*[4]

STUDENT NOTEBOOKS

Articles and clippings from magazines and newspapers were brought to class, read, discussed, and then mounted in individual notebooks. From these we learned that scientists are able to use tagged atoms (radio-active atoms) in studying plant growth, in checking for and treating certain diseases and ailments in the human body, in studying photosynthesis, and in stimulating plant growth.

Diagrams were made of possible generating stations where water might be heated to steam temperature in giant reactors and then piped to steam turbines. Some pupils drew possible ships and planes of the future, powered by nuclear energy.

A worksheet to check the factual knowledge of the pupils was prepared and incorporated into the notebooks.

SOMETHING DAD DIDN'T KNOW

Following our technical study of the atom, we combined our science and social studies classes and discussed the problem of control of atomic weapons, the need for understanding among the peoples of the world, and the importance of building toward world peace.

One of the boys commented at the end of our unit: "It was nice to be able to go home and talk about something my Dad didn't know."

Nuclear energy can be taught and understood in the elementary-school classrooms. The teachers and pupils at Belding School proved it.

OUTLINE OF STUDY

The outline which follows shows how subjectmatter was presented and understandings accomplished in our unit on nuclear energy. It

[4] *Report on the Atom.* 16 mm, sound, 19 min. March of Time Forum Films, 369 Lexington Ave., New York 17, N. Y., 1950.

can be adapted to the needs and interests of any seventh- or eighth-grade class.

1. Of what is the world composed?
   a. What are elements?
      (1) How many elements are there?
      (2) Elements may be combined to form compounds
         (a) We use many compounds in daily life
         (b) Compounds may be broken up into their respective elements
      (3) Elements and compounds may be combined to form mixtures
   b. What are molecules?
   c. What are atoms?
      (1) Of what is an atom composed?
         (a) The nucleus, made up of protons and neutrons
         (b) Electrons
      (2) Why and how do atoms differ?
      (3) What determines the atomic number of an element?
      (4) What determines the atomic weight of an element?
      (5) What are isotopes?
      (6) How may atoms be changed?
         (a) Natural transmutation (radio-active materials)
         (b) Artificial transmutation brought about by betatrons, cyclotrons, synchrotrons
      (7) How is energy within the atom released?
         (a) Fission
         (b) Chain reaction
   d. How does the atomic bomb work?
   e. What is the difference between the atomic bomb and the H bomb?
   f. What are the potentials of nuclear energy?
      (1) In war
      (2) In peace
         (a) Agriculture
         (b) Industry
         (c) Medicine

2. What is required of the people of the world to utilize effectively the power locked within the atom?
   a. Research to benefit mankind
   b. Protective measures to guard against atomic attacks. (Two films. *Atomic Alert*[5] and *Duck and Cover*,[6] may be used.)

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[5] *Atomic Alert.* 16 mm, sound, 16 min. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill., 1951.

[6] *Duck and Cover.* 16 mm, sound and silent, 10 min. Castle Films Dept., United World Films, 1445 Park Ave., New York 29, N. Y., 1952.

A Unit on Weather

By C. R. REID
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WEATHER is a topic of universal interest among elementary-school children, and some phase of the subject can be taught successfully at any grade level. The following outline suggests aims and objectives, activities, experiments, and methods of correlation and evaluation.

GENERAL OBJECTIVES

1. To develop a consciousness in the child of the changes that take place in the air around him
2. To provide opportunities which will give practice in developing habits and skills in, and understandings and appreciations of, the use of weather instruments
3. To develop ability to interpret weather conditions in terms of short-range forecasts
4. To develop an appreciation and understanding of the work of the weather bureau
5. To develop an awareness of how weather affects life

SPECIFIC OBJECTIVES

1. To learn the meaning of weather
2. To notice weather changes and to try to understand why weather changes
3. To learn *why* weather is forecast
4. To learn *how* weather is forecast
5. To learn to read weather maps
6. To learn where to obtain weather information
7. To discover how changes in weather affect plant and animal life
8. To study weather sayings and proverbs, and to decide which are based on facts and which are not
9. To develop interest on the part of the pupil so that he will have a desire to do further study on the importance of weather
10. To understand how weather affects transportation, communication, industries, occupations, and recreation
11. To learn more about man's attempt to control weather

INTRODUCING THE UNIT

1. Ask pupils to describe the kinds of weather they have experienced
2. Describe freak storms or other unusual weather
3. Display weather almanacs and calendars
4. Have pupils subscribe to weather bulletins
5. Discuss articles from newspapers and magazines relating to weather

LEARNING ACTIVITIES

1. Teach children the meaning of weather and why weather knowledge is important to farmers, doctors, fishermen, navigators, flyers, and to many industries

2. Teach the meaning of "climate" in contrast to "weather"

3. Teach children that changing conditions in the atmosphere cause changes in weather

   a. The different factors involved in atmospheric conditions are:
      (1) Temperature
      (2) Precipitation and humidity
      (3) Winds
      (4) Air pressure
      (5) Air expansion

   b. The unequal heating of air and seasonal changes are due to:
      (1) Latitude or the angle at which the rays of the sun strike the earth
      (2) Distribution of land and water
      (3) Altitude
      (4) Mountain barriers
      (5) Ocean currents
      (6) Rotation and revolution of the earth

   c. The temperature of the air and the amount of moisture in the air determine various types of precipitation
      (1) Warm air holds more moisture or water vapor than cold air
      (2) Types of clouds: cirrus, stratus, cumulus
      (3) Types of precipitation: rain, sleet, snow, hail, dew, frost, fog or mist, smog

   d. Expansion and contraction of air when heated and cooled causes air movements and winds
      (1) Cause of convection currents:
         (a) Cold air weighs more than warm air
         (b) Cold air sinks and pushes warm air up
      (2) High and low pressure areas: gales, cyclones, hurricanes, tornadoes, typhoons, monsoons
      (3) Effect of winds on weather and life:
         (a) Relation to rain
         (b) Dust storms
         (c) Erosion
         (d) Mechanical work
         (e) Effect of wind direction on certain kinds of weather in locality

   e. There is an excellent opportunity here to stress the climatic zones into which the northern and southern hemispheres are divided
      (1) Each pupil should be able to locate the zones on a globe
      (2) Show by use of maps how various regions of the world fit into climatic zones
      (3) Have the children:
         (a) Write letters to the U. S. Weather Bureau to find out how it gathers information by the use of thermometer,

barometer, anemometer, wind vane, rain gage, and sounding balloon

(b) Construct and use a thermometer, barometer, wind vane, and rain gage

(c) Obtain weather maps from newspapers and nearest weather station and learn to read them

(d) Prepare reports on the value of weather forecasts to: farmers, shippers of fruit and vegetables, flyers and navigators, and the highway department

A visit to one of the city parks provided important information about trees.

Public Schools, Sheboygan, Wisconsin

(e) Select a weather chart committee to plan and make a large wall chart on which daily weather information can be kept
(f) Cut out the weather predictions from the newspapers each day. Paste them on a piece of paper and opposite each write what the weather actually was. How often is the prediction correct?
(g) Post on the bulletin board each day clippings, pictures, and maps showing climate and weather conditions in various regions
(h) Visit the local weather station or airport to see how weather is studied and recorded
(i) Collect weather sayings and proverbs; determine whether or not each is based on scientific principles
(j) Discuss the many attempts which have been made to control weather; for example, the use of airplanes and smudge pots to control frost and the many rain-making attempts

EXPERIMENTS AND OBSERVATIONS

The sun warms the air—Place one thermometer in the sun and another in the shade. After some time, note the difference in the temperatures.

Air has weight—Weigh a football, basketball, or balloon, before and after putting air into it. What does the experiment show?

Land heats and cools faster than water—Place a thermometer in a cup of dirt. Place another in a cup of water. After both have been left in the sun for some time, read the temperatures. Discuss why the recordings differ.

Water evaporates into the air—Place a small amount of water in a pan. Let it stand for 24 hours. What happens to the water?

Evaporation has a cooling effect—Place two thermometers in the air with a damp cloth over the bulb of one. Notice the difference in the temperature readings.

Water vapor in the air condenses—Hold a cold plate near the spout of a boiling teakettle. What happens?

Cool air forces warm air to rise—On a cold day, open a window a little at both top and bottom. Fasten streamers of paper at the top and bottom. What happens to the streamers?

CORRELATION WITH OTHER SUBJECTS

1. Spelling
   a. Learn to spell all the terms used in forecasting and studying weather that are on sixth-grade level
   b. Learn to spell the names of weather instruments
2. Arithmetic
   a. Use of rulers
   b. Reading thermometers
   c. Reading barometers
3. Language arts
   a. Writing letters to U. S. Weather Bureau
   b. Writing story about the unit for the town newspaper
   c. Giving oral reports on weather topics

d. Ordering pamplets from various agencies of government
4. Reading
   a. Reference reading to find and verify information
   b. Short stories in science texts
   c. Newspaper and magazine articles
   d. Weather bulletins
5. Art
   a. Drawing weather chart
   b. Painting and drawing clouds, snowflakes, rainbows, thunderstorms, and trees bending in the wind
   c. Free-hand cutting of snowflake forms

EVALUATION

1. Observe if children retain interest in radio and newspaper forecasts
2. Observe if pupils have developed skill in reading and handling instruments used in this unit and in performing experiments
3. Observe ability of pupils to make use of reference material
4. Plan informal class discussion to appraise subjectmatter again
5. Evaluate progress from time to time by oral, essay, or objective tests
6. Observe enthusiasm of group participation in various types of activities relating to this unit
7. Evaluate the ability of the pupil to observe those weather conditions which aid him in forecasting weather

MATERIALS OF INSTRUCTION

1. Films and filmstrips
   a. *Our Earth.* 16 mm, sound, 11 min. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill., 1937.
   b. *Work of the Atmosphere.* 16 mm, sound, 11 min. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill., 1935.
   c. *Wearing Away of the Land.* 16 mm, sound, 11 min. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill., 1944.
   d. *Weather.* 16 mm, sound, 10 min. Gateway Productions, 1859 Powell St., San Francisco 11, Calif., 1951.
   e. *What Makes Rain?* 16 mm, sound, 10 min. Young America Films, 18 East 41st St., New York 17, N. Y., 1946.
   f. *Story of a Storm.* 16 mm, sound, 10 min. Coronet Films, Coronet Bldg., Chicago 1, Ill., 1950.
2. Weather maps
   a. From newspapers
   b. From weather stations
3. Pictures and charts
   a. From newspapers
   b. From magazines
   c. From weather stations
4. Community resources
   a. Agencies like the weather bureau, radio station, airport, and newspapers
   b. Specialists like college instructors, pilots, and weather observers

A Sixth-Grade Unit on Coal

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A UNIT on coal offers a great variety of opportunities to develop in children many of the important basic concepts of science. The following outline, designed for sixth-grade classes, illustrates how the topic can be developed effectively.

UNIT THEME

Coal is a form of matter from which man derives a great amount of energy.

UNIT CONCEPT

Man uses energy from coal to drive engines, heat homes, and make gas.

OBJECTIVES

Like the unit beginning on page 108, this outline devotes much space to aims and objectives—35 anticipated outcomes are listed under seven classifications.

Knowledge

1. Coal is a product of nature
2. It took a long time for coal to form. The first coal deposits started over 300 million years ago
3. Time and pressure helped coal to form
4. Coal is still forming today beneath our earth's crust
5. The North American continent has one-half of the earth's developed coal
6. The greatest seam of developed coal in the United States is in the Appalachian region
7. The development of coal according to degrees of hardness is: peat, lignite, bituminous coal, and anthracite coal
8. Energy is the ability to do work
9. Coal has a lot of potential energy
10. Energy is neither created nor destroyed by man
11. Almost half our nation's power comes from coal
12. Coal mining is a big and important industry in the United States

Attitudes

1. We need to conserve our natural resources
2. The supply of coal is not endless

3. We need to find an energy substitute which will take the place of coal
4. Coal mining is essential to the welfare of our nation
5. People engaged in the coal mining industry are doing a great service for our nation

Skills

1. Develop ability to read the books of the bibliography with clarity and understanding
2. Improve one's vocabulary by using the new words found in the study of coal
3. Learn to spell new words found in the unit
4. Develop ability to think clearly, write lucidly, and speak understandingly on the subject of coal

Habits

1. Develop habits of good reading
2. Develop habits of being a good committee worker
3. Develop habits of being a good research worker
4. Develop habits of reliability and accuracy
5. Develop habits of being an original thinker

Wholesome Interests

1. Develop an interest in nature and in the natural forces about us
2. Develop an interest in working together for a common cause
3. Develop an interest in and concern for the conservation of natural resources

Scientific Attitude

1. Develop a respect for the scientific method
2. Learn about its use in discoveries of coal, development of coal products, and in finding substitutes for coal

Appreciation

1. Appreciation of man's place in nature as a beneficiary of heat and light from the sun
2. Appreciation of nature's ways of storing up energy in various forms of matter
3. Appreciation of the harmony of the laws of nature
4. Appreciation of the work of those engaged in the coal industry and of the role they play in the nation's welfare

MAJOR PROBLEMS

1. Where does coal come from?
2. Is coal made by man?
3. Is coal a type of rock?
4. What is coke?
5. What makes some coal soft and other coal hard?
6. What is in coal that makes it burn?

7. What is the difference between anthracite coal and bituminous coal?
8. Why is coal found in some parts of the United States and not in others?
9. What is peat?
10. Are coal deposits an indication that the surrounding area was once a tropical area?
11. How long did it take coal to form?
12. Does the United States have more bituminous coal or more anthracite coal?
13. How is coal mined?
14. What is the value of the coal mined in the United States each year?
15. What are the uses we make of coal?
16. What different products do we make from coal?

PUPIL ACTIVITIES

1. Have pupils state the problems which they have in mind about coal and coal mining
2. Have the secretary of the class record these problems after they have been stated, defined, and clearly worded
3. Appoint committees to do research on the different problems
4. Have committee reports, orally, in written form, or by the use of graphs and charts
5. Make a chart showing uses and things made of peat, lignite, anthracite coal, bituminous coal, and graphite
6. Make a map of the United States locating the coal fields
7. Write themes on different subjects relating to coal and coal mining such as: "Coke and Its Uses," "Coal Tar," "The Story of a Coal Mining Town," "The Graphite in My Pencil"
8. For art work make a mural showing the handling of coal from the mine to the furnace
9. Practice the vocabulary words selected by the vocabulary committee
10. Practice the spelling words selected by the spelling committee
11. Meet as a group from time to time to discuss the findings of the various committees
12. Construct a play to be dramatized before the PTA
13. Make a display or exhibit of coal and coal products
14. Hold an open house for the fifth grade or some other class

TEACHER ACTIVITIES

1. Prepare the room by use of the bulletin board or by bringing samples of coal, peat, lignite, and graphite to class
2. Introduce the unit with an informal talk on coal. Make revealing statements that will arouse the curiosity of pupils such as: "Pennsylvania was once covered with a tropical forest and had many swamps." "Coal is what remains of trees," "Coal is made up of carbon and so are diamonds"
3. Place books listed in the bibliography in the room library
4. Show work that former students did on this subject

5. Give a preliminary showing of the filmstrip, *About Our Earth*,[1] and come back to this filmstrip later on for mastery work
6. Place pictures on the bulletin board showing mine shafts, elevators, views inside the mine, miners digging coal, a coal tipple, and how coal is loaded on railroad cars

VOCABULARY WORDS

1. decomposition
2. deposit
3. swamp
4. coal
5. peat
6. anthracite
7. bituminous
8. carbon
9. tropical
10. Appalachian
11. Pennsylvania
12. lignite
13. graphite
14. coal tar
15. products

MATERIALS

1. Books about coal for room library
2. Samples of peat, lignite, bituminous coal, and anthracite
3. Fossils that are found in coal
4. Picture file and newspaper clippings on coal for bulletin board

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Reed, W. Maxwell. *The Earth for Sam*. Revised edition. New York: Harcourt, Brace and Co., 1941. p. 111, 118, 214-15.

[1] *About Our Earth*. 26 fr, silent with color. Curriculum Films, 41-17 Crescent St., Long Island City 1, N. Y., 1947.

The teacher can avoid the pitfall of rigid and formal instruction by exercising the imagination and curiosity of all children. The teacher in turn must use her experiences and imagination to provide a mobility of ideas. There is no subject which allows the teacher greater freedom in developing effective and progressive methods of teaching than does science. Science itself is progressive. Within the problem-solving frame of this broad science we may place not only the interaction of a schoolwide program but also the individualism of the questions which are of concern to our little people, who, after all, will soon be our big people—seeking more valid answers to further problems.

—DAVID BENGELSDORF, "The Elementary Teacher's Task in Science," *Science Teacher*, November 1952.

Grade Placement of Science Principles

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THRU an investigation carried on in cooperation with elementary science experts and elementary-school science teachers, the grade placement of some physical science principles for elementary grades was undertaken in 1951-52.[1] Basically, the survey consisted of the following problems (a) to determine the physical science principles that should be included in the curriculum, (b) to determine the reasons for the inclusion of the principles, and (c) to determine the grade areas in which the principles should be introduced.

BACKGROUND OF STUDY

A doctor's thesis written by Martin L. Robertson in 1934[2] prompted the survey. Robertson, together with a jury consisting of three representatives from the department of science of the University of Michigan High School, selected a list of principles and checked them against certain criteria. A list of 243 principles and subsidiary principles was compiled. This list was then submitted to 20 supervisors and professors of elementary-school science who rated the principles. From this rating a final list was prepared. This list reduced the total to 113 principles. The foregoing procedures served as a starting point for this investigation.

From Robertson's list those principles dealing with the biological sciences were eliminated and all the physical science principles were retained, leaving a total of 81 principles.

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[1] Leonelli, Renato E. *The Selection and Grade Placement of Physical Science Principles in the Elementary School Curriculum.* Doctor's thesis. Boston: Boston University, 1952. 239 p. (Typewritten)

[2] Robertson, Martin L. *A Basis for the Selection of Course Content in Elementary Science.* Doctor's thesis. Ann Arbor: University of Michigan, 1934. 264 p. (Typewritten)

A JURY OF 101

Seventeen specialists were selected on the basis of their prominence in the elementary-school science field as evidenced by textbooks written, articles published, membership on national committees, and professional positions. Each of the specialists also suggested to the investigator some teachers who were actively engaged in the teaching of science in the elementary grades. A final list of 148 individuals was thus obtained, representing sections from all parts of the United States with the exception of the West Coast. From this group of jurors a total of 101 responses was received. This was a 70-percent return.

SURVEY RESULTS

The responses received on the selection of principles suitable for inclusion in the curriculum were divided into two categories: (a) those accepted by the teachers who were actively engaged in the teaching of elementary-school science, and (b) those accepted by the specialists.

Seventy-two of the 81 principles were selected as being suitable for inclusion in the elementary-school curriculum by a majority (actually by more than 53 percent) of the combined jurors. It is to be noted that 53 percent of the classroom teachers checked 72 of the 81 principles, while 53 percent of the specialists selected only 48 of the 81 principles. The correlation (Pearson) between the selections of the specialists and the selections of the teachers was 0.83.

Closely paralleling this phase of the study was a check made by the same juries relating to the acceptance of the terminology used in the principles. One-half the jurors voted for acceptance of 58 principles as stated, and more than one-half rejected 23 of the principles as stated.

Reasons for Including Principles

A score sheet was sent to the jurors and they were requested to check off the principles which they believed would help achieve certain aims or objectives. These aims were selected by the investigator after a study of the literature and after several meetings with educational specialists. The aims finally established for the inclusion of the principles in the curriculum were that the principle contributed to a change in pupil behavior thru:

1. An interest in and an interpretation of the environment
2. Desirable habits of work and study
3. An interest in the conservation of natural resources
4. Personal or community health and safety
5. Its applicability in a democratic society.

Public Schools, Long Island, New York; Photographer: Tec-Ler→

CHRISTMAS
CACTUS
Peace on Earth
Carnation
MILK
Carnation
MILK

Each of the above aims has been classified by various experts in education as important for pupils today.

Seventy of the original list of 81 principles were included by more than half the jurors because these principles contributed to an interest in and interpretation of the environment (number 1). Among the highest ranked principles were the following:

Like magnetic poles always repel each other and unlike magnetic poles always attract each other.

Sound is produced by vibrating matter and is transmitted by matter.

The principal cause of wind and weather change lies in the unequal heating of different portions of the earth's surface by the sun; thus, all winds are convection currents caused by unequal heating of different portions of the earth's atmosphere, and they blow from places of high atmospheric pressure to places of low atmospheric pressure.

When rated for their contribution to desirable habits of work and study (number 2), no one principle received a majority choice. The principles that rated highest in this category were the following:

The work obtained from a machine never exceeds the work put into it.

If a beam of light falls on an irregular surface, the rays of light are scattered in all directions.

The above principles were selected by one in every four jurors. All the remaining principles were less acceptable.

For inclusion in the curriculum based upon their contribution to conservation of natural resources (number 3), the following principles were selected by more than 50 percent of the jurors:

Every stream is a part of a large drainage system which is wearing down the land surface.

What water breaks down in one place, it builds up in another.

Two groups of forces are constantly acting upon the earth's surface, one building it up, the other tearing it down.

Erosion takes place in inverse proportion to the resistance of the rocks to decomposition and disintegration.

Oddly enough, among those principles which were rejected by more than half the jurors was the following:

Falls or rapids in a stream bed will be formed wherever the stream flows from a hard stratum to a softer one.

When the principles were being considered from the point of view of personal or community health and safety (number 4), and their applicability in a democratic society (number 5), no one principle received a majority selection.

Grade Placement of Principles

The final section of the survey attempted to determine the grade placement of the science principles. Three methods can be generally employed for this. The first method, which investigates present practice, consists of analyzing current courses of study and setting up a frequency chart. Another method of placement uses an experimental procedure. The third method, employed in this investigation, is the obtaining of opinions of experts and individuals in their proper fields. This method is used quite generally today in making curriculum guides and in writing textbooks.

In this part of the survey the jurors indicated the grade level at which the principle, in their opinions, could best be introduced. The results indicated that in no instance did more than 50 percent of the jurors select any single grade for the introduction of a principle. However, upon combining the percents obtained for two or three successive grades, a definite area was established for the majority of the principles. Sixty-four of the 81 principles were thus placed in the grade areas in the elementary-school curriculum. Some of the results are presented here.

The principles listed below received majority support for the fifth- and sixth-grade area:

Elements or compounds may combine to form other substances.

All matter is composed of single elements or combinations of several elements, and can be analyzed by chemical processes and divided into these units.

Light travels in straight lines in mediums of uniform density.

When light waves strike an object, any one or more of these results will follow: they will be absorbed, they will be transmitted, they will be reflected.

If a beam of light falls on an irregular surface, the rays of light are scattered in all directions.

The principles that follow are some that received a selection greater than 50 percent for inclusion in an area consisting of Grades IV, V, and VI:

No chemical change occurs without an accompanying energy change.

The darker the surface is, the better it absorbs light.

Certain forms of energy travel in waves.

Compression of a confined gas increases its pressure.

A body at rest or in motion will remain at rest or continue in motion in a straight line until some force acts upon it.

The higher the temperature of the air, the greater the amount of moisture required to saturate it.

Bodies of land heat up and cool off more rapidly and more readily than do bodies of water.

The following principles were selected by a majority of jurors for placement in the fourth- and fifth-grade area:

Like electrical charges repel and unlike electrical charges attract.

Every stream is a part of a large drainage system which is wearing down the land surface.

What water breaks down in one place, it builds up in another.

In the third- and fourth-grade area, the following ranked high:

Like magnetic poles always repel each other, and unlike magnetic poles always attract each other.

An electrical current may be produced in three ways: by rubbing or friction, by chemical action, by using magnets.

Every stream is a part of a large drainage system which is wearing down the land surface.

The second grade was chosen least frequently for the introduction of principles, while oddly enough, six principles received a fairly high rank for introduction in the first grade. Four high-ranking principles for the first grade were:

Any body of liquid free to take its own position will seek a position in which all surfaces lie in the same horizontal plane.

Sound is produced by vibrating matter and is transmitted by matter.

Things happen according to law, effect follows cause, and to every action there is an equal and opposite reaction.

Whenever an opaque object intercepts rays of radiant energy, a shadow is cast behind the object.

AGREEMENT BETWEEN TEACHERS AND SPECIALISTS

The validity of grade placements was further emphasized by the fact that the specialists and classroom teachers consulted agreed consistently on those principles that should be included in the elementary-school curriculum, and on the choice of grade areas to which they should be assigned.

. . . man has long feared the unknown and so invented fanciful explanations for it. The medicine man, the omen, the lucky charm, the sacrifice to idols, the Greek gods were invented by man in his attempt to conjure up explanations of the environment. Hoaxes, superstitions, and other fanciful inventions became dominant centuries ago and remain dominant for many even today. Science, a new adventure on the part of mankind, introduces experiments, tests, objectivity, realism, and an entirely new way of viewing the environment.

—GERALD S. CRAIG, *Science in Childhood Education*, Teachers College, Columbia University, 1944.

CHAPTER FIVE

Methods of Teaching Science

How should science be taught in the elementary school? Should it be organized as a separate area with a specific amount of scheduled time allotted to it, should it be handled entirely thru integration with other subjects, or should it be a part of a core program? Altho the chapter does not attempt to settle the controversy, it gives arguments in support of popular points of view and presents examples of how various plans might work. Most of the partisans of the separate subject, integration, and core ideas agree, however, that effective teaching of science at the elementary-school level requires much cooperative planning, widespread pupil participation in a great variety of activities, and evaluation which emphasizes the *how* rather than the *what*, *when*, and *where* of science. Teaching methods should be consistent with the purposes of science education.

Science Actuates the Social Studies

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A CERTAIN senior in college was assigned to do her practice teaching with a class of fifth-grade children. She was confronted with a study of "Western Expansion," since that was the current topic prescribed by the course of study. She first won the class over to the idea of pursuing the study in the form of an imaginary trip in the historical context of pioneering days. They decided to call it "Our Covered Wagon Unit." She then proceeded to overview the study as a venture to be undertaken by the children and classroom teacher together. The enthusiasm was high and the anticipation of an exciting study became well established.

ASSUMING THE ROLE OF PIONEERS

The children were to pull up roots and sever themselves from their relatives and friends, supposedly forever. They had to formulate reasons, historically, why they were going. They had to decide which trail to choose, the Oregon Trail or the Santa Fe Trail, with the decision based on a comparative study of the advantages each offered at that time. The venture would also call for a study of the careful preparations for the arduous trek over long dusty trails, for the fording of rivers and crossing of mountains. They had to plan to provide food, fire, water; to protect themselves against hostile Indians; to overcome the physical obstacles of heat, dust, and storm; and to face the possibility of death on the trail. The teacher chose to allow color and picturesqueness to enter the procedure in the form of song, costuming, and dramatization when such would accentuate the realities of the pioneering venture.

GETTING INFORMATION

It was only a short time after the group became organized for study that things began to happen. Information poured into the classroom: knowledge of prairie schooners and how they were built and used to ford rivers; habits of the buffalo herd as their grazing lands were reached, and the story of their near extinction and the present efforts to preserve them.

The study yielded numerous problems that stimulated simple experimentation to find the answers, as for example, using "buffalo chips" for fuel. The class found that weather-leached manure when dry would burn like peat and produce a hot fire.

A flintlock musket and a pistol were brought in. They learned how these were used by the pioneers to protect themselves and to hunt their meat, and how "flint and steel," were used to kindle fire.

EXPERIMENTING WITH FIRE MAKING

The class made its own tinder. They put a wad of cotton cloth into a small tin can with the cover pressed on, and punched a hole thru the cover with a nail to allow the fumes to escape. They roasted this over the flame of the gas stove. As the fumes escaped thru the hole, they were ignited and burned to prevent the odors from filling the room. When the fumes ceased to appear, that was the cue that the cotton had been reduced to charcoal. After the can had cooled, they removed the cotton char. This was to be their "fine tinder." They had shredded a quantity of bark from a cedar log for their "coarse tinder." They secured a flat metal file for the *steel* and a lump of hard rock for the *flint*.

To get the fire, they placed a wad of bark on a cooking pan and a wad of cotton char upon the bark. They proceeded then, while holding the rock just above the tinder, to strike it with the steel file, causing showers of sparks to fall upon the tinder and kindle it. Then they blew against it until heat from the glowing tinder kindled the bark into flame.

After they had started fire this way, they began to think of other ways sparks could be formed to kindle their tinder. They held the steel file against a grinding wheel and made showers of sparks that kindled the tinder. They repeated this with sparks from a kitchen gas lighter and from a cigarette lighter, and got fire both ways. They were impressed by the discovery that we are still using these vestiges of primitive man in this modern era. The interest was so high in this part of the study that they followed thru with a demonstration of the *bow and drill* method (friction), and sensed that the modern match employs the method of friction also, only it is much easier to use and more dependable. These experiences seemed to impress them with the way science lightened the burdens our forerunners had to bear.

PLAINS, RIVERS, CANYONS, MOUNTAINS

As they moved across the vast reaches of the prairies, they could not ignore the Grand Canyon of the Colorado. It came in for study along with the adventures of the one-armed pioneer who first explored it.

They were frequently tempted, out of their map knowledge, to mention cities and the crossing of states in their discussions, and occasionally had to be reminded that there were none of these; that only plains and rivers, plateaus and mountains, presented themselves to the pioneers.

As the mountains began to loom up from the horizon, problems arose concerning their giant ruggedness and their origin. Why should they discover such rugged mountains here, whereas the mountains they left at home were only rounded hills? Young mountains and old mountains and causes of mountain growth came in for study. They also discovered the minerals. The principal of the school, who was following the study with interest, had a certain flair for mineral collecting. A considerable display of minerals and precious metals was assembled by her and the families of the children.

AN IMPRESSION OF GREAT CHANGE

The children seemed to be gaining their first impression of how vast and untamed this land was and how different it is now that it is occupied by cities and people, all connected by a maze of railroads, highways, and airways.

They learned the story of Ezra Meeker [1] who at 17 set out over the Oregon Trail with his young wife of 16 and a baby boy six months old. In the arduous six months the Meekers suffered all the rigors the children had studied about. The class learned, too, that after 50 years or more had passed Meeker returned east by ox cart to raise funds to put monuments along the Oregon Trail to mark the burial places of the thousands of fathers and mothers and babies who had died from the hardships of the long journey. They also learned that Meeker made a trip east by railroad and another by automobile, and at the age of over 90 he made a trip by airplane.

SCIENCE AND A NEW NATION

In the study of this unit the children were given a chance to sense how science had made it possible to conquer the land and unite our vast nation into a people of one thought, almost in the span of a single lifetime—that the country had lost neither its romantic charm nor its grandeur in the process. It can be hoped that these children at least might be able to regard "America the Beautiful" with a greater sense of perspective and realistic reverence because of the understandings and experiences they gained from this venture.

[1] Meeker, Ezra. (Revised and edited by Howard R. Driggs.) *Ox-Team Days on the Oregon Trail.* Yonkers, N. Y.: World Book Co., 1922. 220 p.

Evaluating Science Teaching

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SCIENCE educators, whose domain has been extended downward in recent years to include the elementary school, are most concerned with teaching for understanding in science and with the transferability of these acquired understandings of science to the problem situations of everyday life.

THE "BIG IDEAS" OF SCIENCE

Science is not a mere collection of isolated facts and observations, but an interrelated body of knowledge capable of test and possessing considerable scope, precision, and coherence. In the elementary school some appreciation of the scope, precision, and coherence of science is desirable; but the main objective should be the operation of the *big ideas* of science in the lives of boys and girls here and now. The level of understanding of the *big ideas* of science and their application to daily living will be lower in general for the elementary-school pupil than for the secondary-school pupil; but, even here, considerable overlap will occur in terms of individual differences in ability and interest.

One might ask the question: "Why stress the *big ideas* and their application?" Heretofore our criteria of learning have been limited for the most part to rate and accuracy. For example, how many facts do we know and how quick are we in recalling these facts? In other words, we as teachers of science in the elementary school have stressed *what, when, where,* and *who* questions rather than *how* questions.

By *how* learnings we mean how facts and events are related to one another—how something causes or comes from something else, or how a change in one situation is associated with change in another. How, for example, does the draining of swamps or the cutting of trees result in changes of great importance to plants, animals, and man living in an area?

By *how* learnings we also refer to the methods and procedures that

are used in solving problems, in getting information and understanding, and in putting these to work in living. For example, too often our teaching has stressed the location of planets and stars and their discoverers rather than an understanding of the solar system or the universe. Our teaching has stressed the fact that tuberculosis is caused by a specific organism discovered by Robert Koch in 1882 rather than an applied understanding of the germ theory of disease. We have stressed the fact that the electromagnet is a useful device perfected by Joseph Henry rather than an understanding of the principle of science which makes it operate.

To be sure, these facts are important, but educational research has shown that the retention of *big ideas* is greater than that of factual information. As more *big ideas* become incorporated with those already acquired, the retention of *big ideas* may increase even more.

It matters not that the child does not know the whole of science. What does matter is that what he knows and understands is his, and that it has potency in directing his daily activities in such areas as health, safety, conservation, and freedom from superstition and ignorance. When he begins to use them intelligently, his understandings of science have value. His knowledge of the germ theory of disease or his knowledge of moving objects may thus actually save his life today or tomorrow. His knowledge has value as he uses it to preserve himself and to live a more useful, pleasant, and responsible life.

MAN MUST BE ADAPTABLE

As the child grows, one labels him as practical and resourceful. He can do so many things so well. Actually, partly because of his greater understanding of science, he has shown adaptability. He can now put his understandings to work with greater ease and in a greater variety of ways. In later years this may prove to be the most of what he has left of his schooling in science. He may, because of his understandings, be able to adapt himself to the changing conditions of his environment. We say, then, that he is learning to solve life's problems. This principle has long been known to be in operation with regard to plant and animal life. The plant or animal adapts itself to a new or changed environment or it dies. Man, in a short life span, must also be adaptable if he is to survive and live his full three score years and 10.

USING CRITERIA OF LEARNING TO EVALUATE GROWTH

The above discussion has shown in a sense the evolution of the psychology of learning and represents the steps a child must take in becom-

ing a partially adaptable person. In other words, our criteria of learning should be extensive enough to include the following:

1. Has the child acquired and retained useful and pertinent science *information* of a factual nature?
2. Has he acquired and retained a workable understanding of the principles or *big ideas* of science?
3. Has he learned to use intelligent methods in adapting to the problems of his life?
4. Has he reached a level of understanding, application, and performance in the above three which is commensurate with his *ability*?

All these criteria of learning should be used in evaluating the growth of children in science with the purpose in mind of developing adaptable youngsters. Does he have *psychological ownership* of what he knows? That is, does he use his knowledge to meet the changing conditions of his environment, and does he have confidence in this knowledge?

A teacher of elementary-school science is, of course, interested in all these criteria, but his daily contacts with pupils will be pitched on one of these levels depending on his own understanding of science and his ultimate goals in the teaching of science.

The purpose of this rather lengthy discussion was to point out that evaluation must be geared to objectives along a continuum from simple understandings and skills and limited adaptability to more complete understandings and complex skills and greater adaptability. Where we as pupils and teachers are on this continuum determines the evaluation procedures to be employed. As long as we operate on a rather low level of understanding near the lower end of the continuum, the ordinary evaluation procedures will suffice. A little thought and ingenuity, however, can lift us off the lower levels of evaluation and place us a bit higher on the continuum. As we and our pupils continue to move upward in an understanding of what we are trying to accomplish, the simpler procedures will no longer evaluate adequately the transfer of understandings and abilities of the pupils.

TYPES OF EVALUATION

To move ourselves and our pupils up higher on the evaluation continuum, we need to:

1. Keep anecdotal records or secure evidence of the degree to which our science instruction operates in the lives of boys and girls
2. Devise written tests describing real-life situations which will afford us an opportunity to appraise the pupil's understanding of the *big ideas* of science
3. Provide opportunities for evaluating students in action on original prob-

lems in science rather than by watching them repeat the experiments performed by scientists in the past. Do they attack the problems in a scientific manner, and do they possess scientific attitudes?

Let us try to give, briefly, some examples of technics which might be applied to each of the above three.

Anecdotal Records

Early autumn: John found maggots on an old bone, and referred to them as "ishy, gooey" things, shuddered at them, but indicated no further interest or understanding.

Late spring of the next year: John found a decaying fish covered with maggots, recognized that they were a form of living thing, evidenced a curiosity about them, asked what kind of living thing they were and where they came from.

An alert teacher will recognize such development as clear indication of wholesome science learning.

Written Tests

Under the heading of written tests such items as the following might be effectively used.

Tests of facts—Simple test items, for pupils able to read and write,

Direct experiences are more effective.

De Kalb County Schools, Lithonia, Georgia

may measure such learning effectively. Examples, such as the following completion items, should be straightforward and simple, and should deal with the facts themselves, not with the obscure phrases often memorized from references.

1. It is (93 million) miles to the sun.
2. An insect has (the number) (6) legs.

Vocabulary items can also be constructed easily, as for example:

1. The members of the sun's family are called (planets).
2. The useful gas we breathe is called (oxygen).

The type of item used should receive careful attention from the teacher. True-false items, for example, should deal with direct information, not with remote, complicated, or "tricky" material. The following are good examples:

T—F 1. The moon is larger than the earth.
T—F 2. Electricity is a liquid which flows thru metals.

Matching items very often are poorly built. Matching exercises should be: (a) relatively short, and (b) all on the same type of material. The following exercise uses matching properly:

Match the following organs with their use in the human body:

Job in the Body	*Organ Which Does Job*
1. ..... pumps blood	BR—brain
2. ..... removes nitrogen waste	HE—heart
3. ..... adds oxygen to blood	KI—kidney
4. ..... stores body starch	LI—liver
5. ..... directs body operations	LU—lung
6. ..... stores and mixes food	SI—small intestine
7. ..... does most digesting of food	ST—stomach

An example of a matching exercise which is *very poor*, because guessing and simple elimination may give practically every answer, is:

1. ..... tall mountain	A. 96
2. ..... distance to the moon	B. electrons
3. ..... number of elements	C. Morse
4. ..... inventor of telegraph	D. Orinoco
5. ..... modern scientist	E. Pike's Peak
6. ..... electrical particles	F. 240,000 miles
7. ..... South American river	G. Zworykin

Note how practically every one of these items can be answered with almost no knowledge of the material which is supposed to be under test.

Tests of understanding—Unless one is careful, however, the teacher may confine her objective testing to factual information only. Most

teacher-made tests and the bulk of the standardized examinations in science fail to provide much evidence of growth in achievement of objectives toward the "understanding" end of the continuum. If one wants to sample understandings of science rather than just factual information, he might devise objective test items, such as the following, for use with upper-grade elementary-school children (note that each exercise asks first for a *factual* answer, then for a *big idea*; both should be answered correctly):

A boy had an ordinary pail full of water. He placed a big, heavy iron bolt and a piece of soft, dry pine wood side by side on the surface of the water. What would probably happen? (Circle only one.)

1. The wood sank to the bottom of the water, and the iron bolt floated.
2. The wood and the bolt both sank.
3. The wood floated and the iron bolt sank.
4. They both floated.
5. The bolt moved over to the side of the pail and stuck there, and the wood just floated on the water.

Which of the following *big ideas* of science gives the best explanation of what happened? (Circle only one.)

1. Things made of wood always float, and things made of iron always sink.
2. The pail was magnetic and so it pulled the iron but not the wood.
3. Water is soft, so all things can move easily thru it.
4. Needles can be made to float on water sometimes.
5. Iron is heavier and wood is lighter than an equal amount (volume) of water, and gravity acts on all matter.
6. Water is composed of two parts of hydrogen and one part of oxygen.
7. On a cold day the water would be frozen, so neither the wood nor the iron would sink.
8. Wood contains air but iron does not.

A boy at a track meet stood by the finishing tape and watched his friends run the 220 yard race. (This is a little over two city blocks long.) He was very much surprised at what happened when the man fired the starting gun at the other end of the track.
What had the boy probably noticed that surprised him? (Circle only one.)

1. He saw the smoke from the gun before he heard the noise of the shot.
2. He heard the noise of the shot before he saw the smoke.
3. The sound of the gun and the flash seemed to come at the same time.

Which statement below gives the *big idea* or principle which you used in choosing your above answer? (Circle only one.)

1. The wind blew the sound of the shot ahead of the smoke.
2. It takes a little while for sound to travel, but things can be seen instantly. Therefore, he heard the sound after he saw the smoke.
3. Different forms of energy (light and sound in this case) travel at exactly the same speed.

4. The smoke gets out of the gun faster than the sound of the shot, but at two blocks distance no human eye and ear could tell the difference.
5. All forms of energy (light and sound in this case) do not travel at the same speed. Some go very fast, others quite slowly, depending on the material thru which they are passing and the kind of energy.

In using examinations as a means of evaluation, the classroom teacher must be aware of the limitations. Some of the limitations are: (a) measures produced by tests are susceptible to error of measurement, (b) tests sample knowledge in artificial situations and hence are only a convenient substitute for real-life situations, and (c) tests may sample science knowledge and understandings quite unsuitable in terms of the local school and its objectives.

Evaluation of Behavior

Behaviour can be evaluated by the alert teacher who is a constant observer of his pupils' behavior and reactions. As a guide for such observation the teacher might have in mind questions such as the following:

To what extent does the child:

1. Recognize problems or show curiosity about his daily surroundings?
2. Suggest answers or methods of problem solving, rather than use "fairy-tale" answers?
3. Differentiate between the value and reliability of different sources of information?
4. Draw conclusions carefully or jump quickly to conclusions?
5. *Use* learning, rather than just *recite* learning?

To what extent, also, does the child show an increasing appreciation and understanding of such points as these?

1. Natural events, such as thunder and disease, have natural causes
2. New discoveries and inventions require us to change our ways of living
3. Science has been developed by people of many nationalities and groups
4. Scientific knowledge should be used for the good of all people.

Use of such evaluation is, of course, very challenging to the good teacher because it is so fundamental in the development of the child of today. This is what is meant when questions about scientific attitude, application, and appreciation are raised.

WE CAN EVALUATE ADEQUATELY

If we are mindful of the criteria of learning stressed in this discussion, and if we continue to work to develop technics of evaluation which will probe these criteria as we provide situations of a realistic nature, then we can adequately evaluate each child's progress in science.

Unit Concepts in Elementary-School Science

By NORMAN C. COOPER
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IF SCIENCE is to be taught in the elementary school, it should be science in general and not just phases or highlights of the subject. A single area like botany or zoology, or a further restricted subject like shells or seeds, is not to be thought of as constituting a course in science in the elementary school.

Physics and chemistry are just as important in the life of today's child as the study of a few plants or bugs. Rocks are just as much a part of the child's environment as plants and animals. He needs to understand rocks, too. Meteorology and the forces of air in motion should come in for as much consideration as other phases of science in building the elementary science curriculum. Astronomy and geology are a part of the environment of all and must be given their share of attention if the child is to be at home in his world of moon and stars, plains and mountains. To stress one or two areas of the great field of science in the elementary-school curriculum and leave out the other important areas is to "miss the boat" in this great opportunity for learning.

This article is devoted to certain broad concepts of elementary-school science, particularly to concepts of the various areas that must be included in an adequate program.

ADJUSTMENT

The first great over-all concept is that of *adjustment*. We are teaching science to the elementary-school child purely for the purpose of helping him adjust to his environment. We are not trying to make a chemist, a physicist, an astronomer, or a biologist out of him. He may develop into any one of these later on partly because of his early training in science, but such development is incidental. Our object is to help him adjust himself to his environment by letting him gain experiences with the science materials in his world.

COMPONENT AREAS OF SCIENCE

We should break the field of science down into its major component areas, because we can handle smaller units of science more easily than

science as one big whole. This makes science appear as astronomy, geology, meteorology, biology, botany, zoology, chemistry, and physics. This, however, is not serious because the world of science with each of its subdivisions is the same for the child as it is for the adult. In fact, if we note these subdivisions and gain the central concepts of each one, it enables us to aid the child in gaining clearer ideas of the world about him.

Let us take one area and call it a unit in the great field of science. We work out an over-all central theme for it which will serve as a guidepost in all our thinking and teaching. Then each area of science as a unit can follow with its appropriate concept.

Astronomy

The study of astronomy should stress the concept of great space and the movement of the heavenly bodies in that great space. The child is familiar with space or distance only as far as he has experienced distance in his own immediate environment—the distance from his home to the store, the distance to school or across town to his grandmother's home, or the distance traveled on a trip to the country. These experiences are the bases of the child's concept of space. From these personal experiences of the child should come a concept of space thruout the world, in the solar system, and in the universe. Space meanings to him should change. He should be freed from his back-yard notions of space and distance and be led into new pathways of thinking as his mind travels from planet to planet and from star to star.

Geology

The study of geology should stress the great concept of time, the structure of the earth, and how the earth developed into its present state thru the eons of time. The child is familiar with time only as far as he has experienced time in his own living. To him, scarcely anything happened before he was born. Time to him means the days that have passed since his last birthday, the time from one Christmas to the next, or the number of days left in his summer vacation. From his present concepts should come a concept of time thruout recorded history and thruout the geologic ages.

Meteorology

Meteorology should stress the great concept of change. Change seems to be the only thing that is constant in the universe. Change is constantly taking place in the earth's atmosphere, in the climate, and in weather conditions. Meteorology is an area of great interest to children. The typical elementary-school child asks more questions in this

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Rocks in the collection were tested and identified.

area of science than in any other. There are wonderful opportunities to capitalize on this interest. He wants to know about the wind and the clouds, the rain and the snow, storms, hurricanes, frost, sleet, and ice. His study of meteorology should bring to him the idea that the universe and everything in it is changing just as the wind, the clouds, and the temperature and air currents are changing every minute. He should be led to see that adjustment to change is a continuous process and not one that can ever be completed and forgotten about.

Biology

The study of biology should stress the great concept of interrelationship among the living organisms of our environment—plant and animal. All living things are made up of protoplasm, a basic substance composed of common elements of the earth's matter. Living things are all alike in this respect and as such are interrelated. There is a continuous relationship from the simplest plant to the most complex plant, from the simplest animal to the most complex animal, and from the simplest plant to the most complex animal. The child should see these relationships and form a mature judgment about the world of living things around him.

Botany

Botany should stress the great concept of variation in the plant world and how these myriads of varieties of plants have adapted themselves

to their environment. Emphasis should be placed on the use, control, and economic importance of plants to mankind. Plants vary and the variations that are advantageous to survival are inherited by the offspring. Thus thru the ages varieties are produced by nature that can adapt themselves to environmental conditions which the parent variety could not withstand. By controlled breeding of plants, we can produce and conserve new plants better adapted for our use and consumption.

Zoology

The study of zoology should stress the great concept of variation in the animal world and how the many varieties have adapted themselves to their environment. The use, control, and economic importance of animals to mankind should be emphasized. Animals vary and the variations that are advantageous to survival are inherited by the offspring. By controlled breeding we are producing new animals better adapted for our use and consumption, and conserving present animals that have already proved valuable. Thus, the great concept of zoology is similar to that of botany.

Physics

The study of physics should stress the great concept of the energy of the universe and the interaction of the universal forces; the ways in which man has harnessed energy and forces for his own use. The universe is full of energy—energy in coal, energy in sunlight, energy in oil, electrical energy, energy in wood, energy in running water, and atomic energy. One of man's great problems thruout the ages has been to harness these sources of nature's energy and to find new sources as the old ones become depleted or clumsy to use. The child should be led to an appreciation of the great storehouses of energy in his universe and of man's accomplishments in building machines to harness this energy.

Chemistry

Chemistry should stress the great concept of matter and its place in the universe as it becomes a tool whereby mankind reshapes his entire environment. The universe is made up of matter, and chemistry is the study of changes in the matter of the universe. This matter is all around the child. He does not have to wait to go to college to come in contact with chemistry. It is in the water he drinks, the food he eats, the chalk at the board, the wood in his desk, and the ink in his inkwell. His very body is one of the world's most intricate chemical laboratories, taking in dead matter from the universe and transforming it into living, growing boy.

Science Should Be Integrated and Correlated

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CONFRONTED with numerous scientific advancements in this modern technological world, teachers cry, "We don't have enough time to include another course in our already crowded curriculum." This completely justified complaint signals the need for a review of presentday elementary-school curriculums with a view to providing a more practical and workable course of study for our boys and girls. Effective life in our modern democracy requires a new approach.

NOT ADDED BUT INTEGRATED AND CORRELATED

A good science course today is not one to be added to an already crowded schedule. It is a course to be integrated and correlated with the subjects already taught so as to provide for every child enough science to satisfy his curiosity, whet his interest, and equip him to be a good parent, a wise citizen, an intelligent consumer, and a well-balanced individual.

Science has much in common with the language arts, the social studies curriculum, the health program, the sports program, and, in its more advanced stages, with mathematics. Whether it be in the rural school, the graded school, the experimental school, or the field of special education, it is necessary for us to develop a program which will fulfil the needs of the child—either present needs or anticipated needs—and which will enable him to grow normally into a well-balanced citizen.

Since we do not want to add another burden to the school day, we pair science with English and social studies with reading. Writing and spelling receive detailed attention in both courses. It is logical to think that a part of our reading may be in the field of science; and children, especially boys, write and speak more freely about science than any other topic except sports. Since we do not wish to discourage some girls by forcing them to a detailed understanding of such things as Pascal's Law, we let them apply science to the household arts.

BUILDING AN EIGHTH-GRADE PROGRAM

Come with us as we build a science course for the eighth grade, altho the same method can be followed for any other grade.

What Do We Need To Know?

Classroom teacher and pupils meeting for the first time raise the question, "What should eighth-graders know about science?" Children have some sort of idea that they want to know about planes, electricity, animals, and plants. They know in general that there are interesting and valuable things to know about other worlds, energy, weather, climate, and our earth's changing surface. A challenging question, a thoughtful suggestion, and they recall something said by parents or observed on trips. Someone suggests that experts in the field have made a study of the problem and have listed units they thought important. After a survey of tables of contents and courses of study in several texts, children arrive at a listing of units in which they are interested and for which a

The importance of soil conservation became apparent to all members of the class.

Cold Spring School, Plymouth, Massachusetts

need exists in their experience. In this connection they may apply such criteria as were worked out by another class using this method.

1. Is it something we can use now and in the future?
2. Will we be able to find material and information?
3. Will the unit be interesting to most of the class?
4. Will we be able to take field trips, see movies, or interview people?
5. Will we learn new things?
6. Can we make use of the library, movies, interviews, speakers, pictures, textbooks, field trips, and models?
7. Will we be able to work in committees, make and hear reports, have discussions, make things, and draw?

Building a List of Units

After comparing texts, condensing lists, and combining topics, the children and the teacher arrive at a list of units which is within reach of their ability and which covers the fields in which they have not had adequate experience. Classes also select units on the basis of the areas in which they have not had much activity in previous years. One class made the following selections for study in the eighth grade:

1. Understanding my body
2. Communication and transportation
3. Energy
4. Astronomy
5. The weather
6. Plants and animals.

Selecting One Unit

With the year's program in mind, the class and teacher select the problem or unit most challenging and begin work. The unit is broken down by the class into its subtopics, and individuals and committees start investigations. In an astronomy unit, one class investigated and reported on the following topics:

1. Planets—What is known about each?
2. The sun and other stars
3. Comets, meteors, and meteorites
4. Galaxies and nebulae
5. Constellations
6. Eclipses
7. Asteroids and planetoids
8. Famous astronomers
9. Origin of the universe.

Searching for Information

Sources of information are surveyed by committees or individuals. Sources include encyclopedias, parallel texts, free or inexpensive movies,

free reading materials, and experts in the community. Planning together makes the children aware of these sources.

Individual children or committees are responsible for seeking out for the class the definition of the topic, the sources, the structure, and the uses, as well as finding or making illustrations and models. Available texts provide tables of contents and indexes to be searched for clues to information. Reference books become tools for eager children. Teachers, friends, parents, and neighbors are resources for students in their quest for information as they learn to interview, take notes, and organize material. If these skills are lacking, they are quickly learned when the motivation of immediate use is present.

Using Other Skills

As children gather material and arrange it to present to the class, they accomplish purposeful activity in the language arts. Reading is done purposefully as the child selects material suited to his level of reading ability from his library or from available texts. Where possible, classrooms are provided with texts not only for the grade level of instruction, but also for grades above and below. Since science texts are based on an ascending spiral with the same topics being repeated each year, no stigma is attached to the child who searches for material at a lower grade level. Children seek books on a higher level when they have absorbed the other material at hand. Superior children are guided into contact with more detailed work and more challenging topics.

Note taking, a language arts skill, is introduced as a tool to be used in acquiring scientific knowledge. Letter writing becomes real as students write requests for materials and answers are eagerly awaited. The motivation is sufficient to stimulate all but the most lethargic.

Communications skills are acquired as children strive for variety and effectiveness of presentation. By means of reports, talks, panel discussions, radio programs, lectures, demonstrations, plays, television programs, charts, pictures, dioramas, movies, filmstrips, and illustrated talks, students effectively present the science information to their classmates without danger of talking over the heads of various members.

Speech habits, writing habits, spelling, and penmanship are improved by conscious attention given at the time the material is being readied for presentation. Time is provided for adequate practice.

Learning from Other Children

From the standpoint of scientific information, the pupil is brought into contact with far more material than if he were required to read it in a single text. He develops a respect for opinions when he finds that

authors disagree on some scientific ideas, and he learns to respect copyright dates as he searches for the latest information. The pupil not only acquires material on his own phase as he prepares his report, but also acquires information as he listens to the reports of others. Thus he acquires far in excess of that which he would be able to obtain by himself. The speakers, movies, pictures, models, and other aids produced and used by others serve to provide the motivation for remembering scientific facts.

Evaluation

Evaluation is carried on in many ways. A teacher may formulate questions as he listens to presentations, or children may submit questions on their own reports to be answered by the class in written examinations. Group discussions may reveal what facts were acquired. Extemporaneous themes may be written on topics related to the unit, or problems may be solved in the light of material presented. The unit may be discussed by the class in terms of the criteria set up at the beginning of this article.

Values

Many values are to be realized in this method of subjectmatter presentation. Every pupil, no matter how immature or lacking in native ability, has some obligation to the class. He gains status in the class because he alone is responsible for some phase of the topic, and class approval is often enough to make sure he does his best.

The pupil proceeds to gather material on his reading level at his own best rate, and he presents it, when prepared, to the class. Pupils contract for a time of presentation, volunteer, or draw numbers to determine the order of presentation. They are encouraged to vary their forms of presentation as the teacher becomes aware of their talents and abilities.

PUPIL AND TEACHER GROWTH

Such a program provides for individual differences, keeps children working up to the level of their ability, and enables the teacher to give individual aid to those who need it most while superior students go ahead on their own. The classroom teacher becomes a guide and consultant, seeking information with the child, and student and teacher grow together in scientific knowledge and appreciation as they listen to reports of doings in the world of science.

Science in the Common Learnings Program

By CLOY S. HOBSON
Professor of Education
University of Kansas
Lawrence, Kansas

NO EDUCATOR in the elementary-school field advocates teaching science to children merely so they will know science. Yet many do advocate and practice the teaching of science as a discrete subject with a period of its own in the school day. When taught in a period of its own, science may consist of memorized principles, facts, and unrelated experiences—all in isolation from daily living. The result may be the learning of science for the sake of knowing science.

Many classroom teachers, furthermore, when faced with the necessity of teaching science, remember their experiences as students in college science courses. They did not understand the subject then, and they do not feel competent to teach it now. Consequently, children are led to memorize "safe" textbook material and no real understanding of science and its applications is achieved, except possibly for a few of the academically brighter children.

The fundamental purpose of the elementary school is to stimulate and direct the continuous development of the child in all his characteristics. An alternate purpose is preparation for a higher school or for more advanced work in the subjectmatter fields. The former purpose is realistic in that it is consistent with modern psychological principles and can be achieved. The latter purpose, when attempted directly, is based on unrealistic standards of achievement which cannot be met by the majority of the pupils. It is best achieved, not directly, but as a byproduct of the former purpose. In keeping with this former purpose, science will be taught largely as an instrument of improved daily living and in relation to social activities.

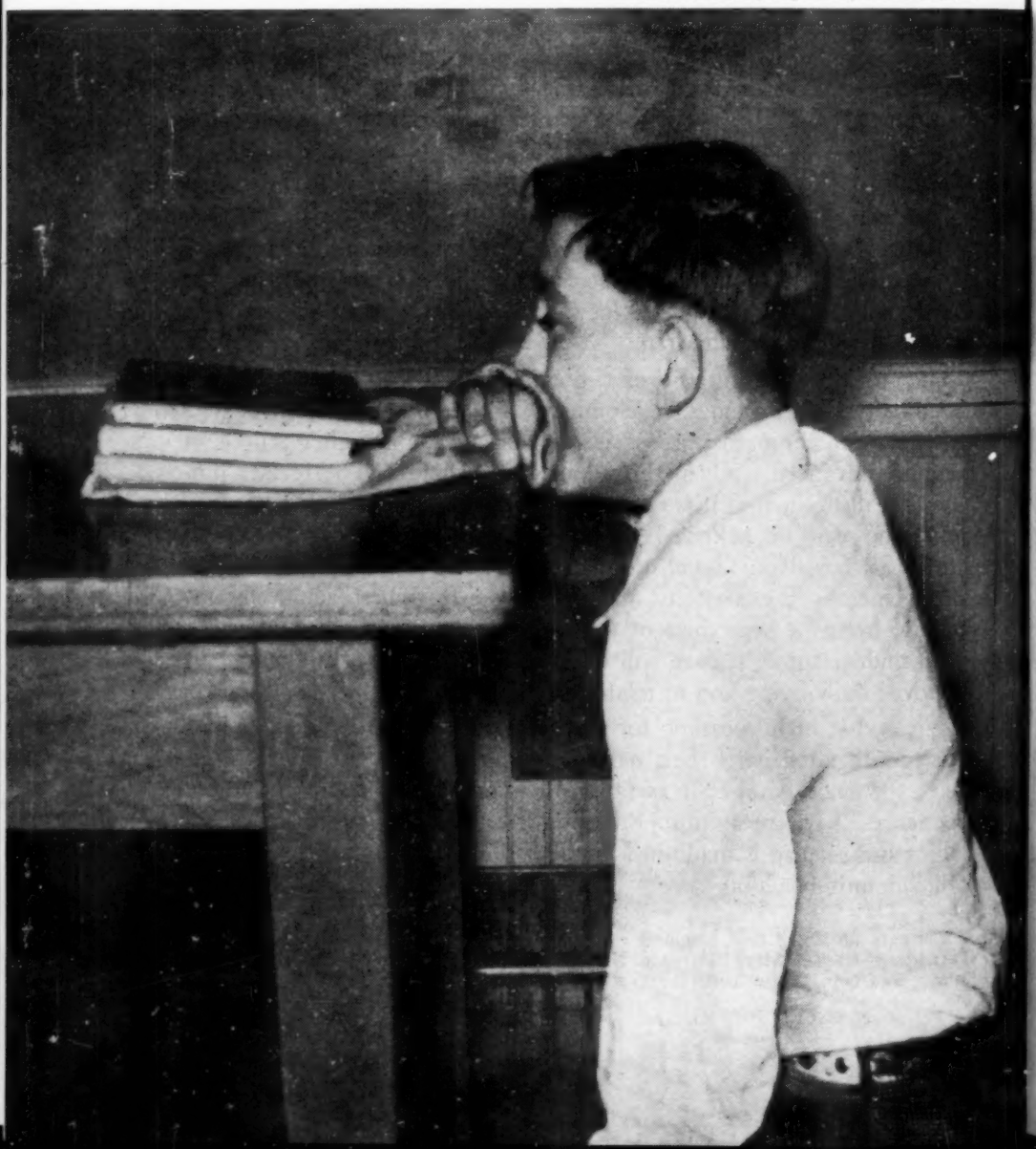
Science has little meaning for the great majority of children except as it is integrated with their daily living. They seek to integrate all their experiences, and only as far as they are able to do so will these experiences have meaning. Provision for the integration of social studies and science is made in a number of Kansas schools by the use of broad unit teaching.[1]

[1] The data on broad unit teaching recorded here are taken from the curriculums of Atchison, Kansas City, Lawrence, Northeast Johnson County, and Salina, all in Kansas, and from the writer's observations in these schools.

The broad unit in these schools is based on the contacts which the children have with their social and physical world. These contacts are closely interrelated in their daily experiences outside the school. When they are used as bases for teaching units in school, they likewise must be closely integrated if they are to be natural and meaningful to the children.

Altho the experiment was not successful, Ralph knew it could be done because it involved the same principle as pumping up a bicycle tire.

Cornish School, Plymouth, Massachusetts



THE BROAD UNIT IN OPERATION

The broad unit in its ideal setting involves four curriculum areas in addition to its social studies and science content: the language arts or the verbal type of communication, quantitative relationships or mathematics, fine and practical arts, and physical competence. The broad unit area occupies the largest block of time in the school day, in contrast to the short class periods of unrelated subjectmatter. This plan not only aids pupils in understanding and participating in their social and physical world, but provides opportunities for application of knowledge and skills developed in the other areas. Indeed, as the classroom teacher and pupils gain increased command of the broad unit as a tool of social and personal development and gain power in integrating the other areas with it, more and more time may be given to it and less and less to the other areas as discrete subjects, without affecting the development of skills or the acquiring of essential knowledge. The broad unit may, in fact, occupy as much as one-third or one-half of the school day in the hands of a skilled teacher and with the cooperation of pupils in formulating objectives and in planning and carrying on learning experiences. Only a few of the classrooms visited by the writer are using the complete curriculum organization described here; others are working toward it.

EXAMPLES OF BROAD UNITS

A list of some of the broad units used in the schools is given below. The order of the listing has no significance, nor are the grade levels of the units designated. These problems can be stated in the language of children at any elementary-school level and appropriate objectives and activities for that level developed.

Why do children of other lands live differently from the way we do?
How can we keep well?
How should we care for our pets?
How do plants and animals help us?
How do machines help us?
How does weather affect us?
How can we communicate with friends at a distance?
What do we see on a farm?
What do we see in the dairy?
How do people in our community provide for their needs?
How is pure water provided in our community?
What provisions are made for sanitation in our city?
How do we find our way about in our big world?
How has communication made our world smaller?
How has the airplane affected our way of living?

Why are the problems of the South Americans (or of any other people) important to us?

What makes our country great?

What makes Kansas a great state?

How have science and inventions influenced our way of life?

How can we increase our enjoyment of life out of doors?

How can we work and play more safely?

How can we keep our community healthful?

How is air used in everyday living?

How do climate and weather influence our ways of living?

How do Kansas people make a living?

Why is the conservation of our natural resources important to the survival of people?

How do living things depend upon the physical elements in their environment?

How do we exchange goods with other people?

How may man change his environment to make living easier and more satisfying?

How can we help in caring for younger children—in our families, as baby sitters, as nursery attendants when mothers of young children visit our school?

How do plants, animals, and people get ready for winter (or for other seasons)?

How has man increased his control over nature?

INTEGRATING SOCIAL STUDIES AND SCIENCE CONTENT

An analysis of the content of the units developed to answer the preceding questions reveals that both social studies and science materials are necessary to give complete answers. Knowledge and skills from other subjectmatter fields also, of necessity, are employed to carry on the unit activities. A partial analysis of content of a few of the units is given to indicate the use of materials from the two fields. Often, it will be observed, the content materials might logically be classified in either field.

How Does Our City Provide Pure Water?

Social Studies Content	*Science Content*
City government	Source of our city's water
Water department	Water cycle
City employees	Gravity flow of water
Taxation	Force pumps
Water metering system	Filtering
State government aids to municipalities	Chemical purification
Public utilities	Bacteria
Public and private ownership	Plumbing
	Water table

What Makes Our Country Great?

Social Studies Content	*Science Content*
Form of government	Geographical size
Public education	Natural resources
The American home	Science and invention
Freedom of religion	National parks and monuments
Freedom of speech	Topography
Great American documents	Scientists and their work
Standards of living	
Economic features	
Opportunities and responsibilities of citizens	
Contributions of pioneers	
Contributions of immigrants	

How Can We Increase Our Enjoyment of the Out of Doors?

Social Studies Content	*Science Content*
Clubs	Animal life
Cooperation in work and play	Plant life
Outdoor games	Physical geography and geology
Political geography	Observations in astronomy
Maps	Outdoor cooking
Parks, sanctuaries, recreation areas	Camp technics
Care and use of equipment	Scientific instruments
	Conservation practices

How Can We Prevent Fire Losses?

Social Studies Content	*Science Content*
City government	Nature of fire
Fire department	Causes of fire
City employees	Electricity and fire
Social cooperation	Rubbish as a fire hazard
Individual responsibility	Care in handling fires
State government (inspectors)	Fire extinguishers
Federal government (rangers)	

How Do Plants and Animals Help Us?

Social Studies Content	*Science Content*
Needs of people	Animal products
Interdependence	Plant products
Communication	Sources of food, clothing, shelter
Manufacturing	Raising plants and animals
Transportation	Catching wild animals for use
Labor	Beneficial biological life (earthworms, warblers, quail, etc.)
Business	Balance of nature

How Can We Help in Caring for Young Children?

Social Studies Content	*Science Content*
Mental characteristics of children	Physical characteristics of children
Social characteristics of children	Need for sleep
Emotional characteristics of children	Need for exercise
	Need for recreation
Play experiences	Need for clothing
Entertaining young children	Need for food
Child behavior	Safety precautions
Personal qualifications of a baby sitter	First aid

How Do Machines Help Us?

Social Studies Content	*Science Content*
Primitive methods of work	Early types of machines
Modern methods of work	Simple machines in the home
Disadvantages of primitive methods	Friction
	Mechanical advantage
Advantages of modern methods	Gravity
Modern uses of free time—rest, recreation, education	Sources of power
	Products of science
Modern economic organization	Use of inventions in industry
Modern influence of power on lives of people and nations	Types of engines today
	Operation of engines

MEETING THE NEEDS OF ALL CHILDREN

For many children the science learned in the broad unit as described here is sufficient for their needs at the elementary-school level. For the few who show great interest and capacity in the field, experiences in science as a discrete subject are necessary in addition to the integrated program of the broad unit. The classroom teacher can provide for these few by individual direction, and by supplying reading materials and direct experiences apart from the activities of the class.

The broad unit serves the integrative function of the school. It helps children to participate more intelligently and helpfully in a world of social and physical contacts. It helps them to see relationships between the customary academic learnings of the elementary school and the world about them. It gives them opportunities for self-direction and for cooperation. It provides the common learnings for everybody, but does not provide the complete curriculum for anybody. Individualization and specialization, outside the broad unit, complete the program for the individual child. Thus may both the integrative and specialization functions of the elementary school be performed.

Summer Classes in Elementary-School Science

By WOODROW NELSON
Principal, Northrop School
Rochester, Minnesota

CECELIA BUSKOWIAK, IVIS CORNWELL, BURNIS EVENSON, and HATTIE SCHROEDER
Classroom Teachers
Rochester, Minnesota, Public Schools

THE Rochester, Minnesota, public schools can have an extended science program because of their unusual system of 11 months of school each year. This past summer the popularity of elementary-school science was proved.

Planning sessions for the summer program were held thruout the year. It was readily seen that classroom teachers felt children needed an opportunity to pursue their own interests in science. For this and other reasons it was decided that there would be no grade distinctions during the summer session. The classes in each school would be divided into two sections: primary grades and intermediate grades. By far the most popular of the subjectmatter courses listed was science. In each school there were primary science classes from 9:00 to 10:00 and intermediate science classes from 10:00 to 11:00 each morning. The session lasted five weeks.

As in other subjectmatter fields, classroom teachers were chosen to teach the courses in which they were the most interested. One teacher who was vitally interested in science was chosen to teach this subject in each of four elementary schools serving the four sections of the city. One of the elementary-school principals who had taken graduate work in elementary science served as adviser to the group, helping in the selection of topics to be studied, advising on places from which materials could be obtained, suggesting subjectmatter aids, and giving helpful hints on experiments.

TYPICAL PLAN

The program in each school was designed solely for enrichment, and the curriculum was based on the interests of children. The subjectmatter discussed, the room environment, and projects carried on varied from school to school. The following outline, however, illustrates a typical plan.

1. Interests developed
   a. Primary group
      (1) Animals
         (a) Those of our nearby surroundings
         (b) Those we have seen in circuses and zoos
         (c) Those we have seen in pictures
      (2) Trees, flowering shrubs, and other flowers
         (a) Those on our school grounds
         (b) Those of neighbors near school
         (c) Those observed during week-end excursions
      (3) Vegetables of our gardens
      (4) Insects
   b. Intermediate group
      (1) Frogs, toads, salamanders
      (2) Birds
      (3) Insects (bees, butterflies, moths, flies, ants, beetles)
      (4) Snakes
      (5) Rock formations
      (6) Air about us
2. Experiences and activities
   a. Primary group
      (1) Reading stories relating to interests
      (2) Writing experience stories
         (a) Wall charts
         (b) Individual booklets
      (3) Drawing pictures to illustrate interests
      (4) Taking excursions
         (a) To Befort's Zoo
         (b) To a nearby vegetable garden
         (c) Walking to observe and identify trees and flowering shrubs
      (5) Caring for and observing two newts in the classroom
      (6) Collecting insect and leaf specimens, and classifying them
      (7) Planning and arranging an exhibit of vegetables and flowers
      (8) Sharing daily experiences pertaining to science out of doors
      (9) Using films and filmstrips pertaining to timely interests
   b. Intermediate group
      (1) Same activities as named for primary group in (1), (2), (3), (8), and (9)
      (2) Excursions
         (a) To a citizen's home to see his wood carvings of birds
         (b) To a doctor's home to see a beehive
         (c) To a florist's home to study rocks in his collection
      (3) Caring for and observing three toads
      (4) Observing some ants brought to the classroom
      (5) Buying honey in the comb and then enjoying bread and honey
      (6) Performing experiments dealing with the composition of air, weight of air, and air pressure
      (7) Keeping a daily weather chart

THE SCIENCE ROOM WAS AN INTERESTING PLACE

Children came at the beginning of the summer session eager, curious, and ready to "find out." Provision was made for boys and girls to plan and work in groups. The science room was an interesting place, not only because of the living things in evidence, but because of the displays and the projects of pupils in action.

Visual aids helped to sharpen interests in objects around the children. Better understandings resulted from the use of pictures found in books and magazines, and from the use of sound films, filmstrips, and microscopes. Charts and numerous objects were available for observation at all times. Colorful science corners appeared each week, proving that pupils were "doing things."

EVIDENCE OF GROWTH

Growth in science was evident as pupils brought objects for study and observation. Children became increasingly aware of their surroundings. Trees, shrubs, grasses, flowers, birds, insects, stones, shells—all had a story to tell, all provided interesting material for study. Ragweed and other noxious weeds harmful to animals were studied, and methods of extermination learned. In this, as in other areas, the classification of the species was not too important. The interest was in finding answers to "What is it?" "Where did it come from?" "Of what use is it?"

Many children came early and stayed after classes were dismissed. Some stayed so long that very often teachers had to ask children to leave the building.

VISITING PARENTS

Much of the work which could be kept was set aside for a science fair which was held on "open house" day. Parents also came to observe during the last week of school. They saw scrapbooks, nature collections, bulletin-board displays, and experiments performed. Each child had a chance to tell the visitors and the class group what he liked best about the summer science classes. During this period bells rang, lights flashed on and off, water boiled, and stoppers flew out of bottles.

EVALUATION

One of the best statements on the evaluation of the summer's science classes came from one noisy lad who exclaimed: "I liked best the day that I made a bell ring and a light light up at the same time with two batteries. My teacher didn't tell me how to do it, either."

It was interesting to note how enrolments in science classes grew as the summer progressed. Children went home, advertised what was going on, and, consequently, recruits were added each day.

Yes, science was fun here, not just for the children, but for the four classroom teachers who led the program in each of the schools. It was great fun, too, for the principal who helped the teachers plan their work for the summer. It was fun for the parents who came to see the results of their children's activities. It was even fun to look forward to the next summer's program.

Some of the significant results of the summer science classes were these:

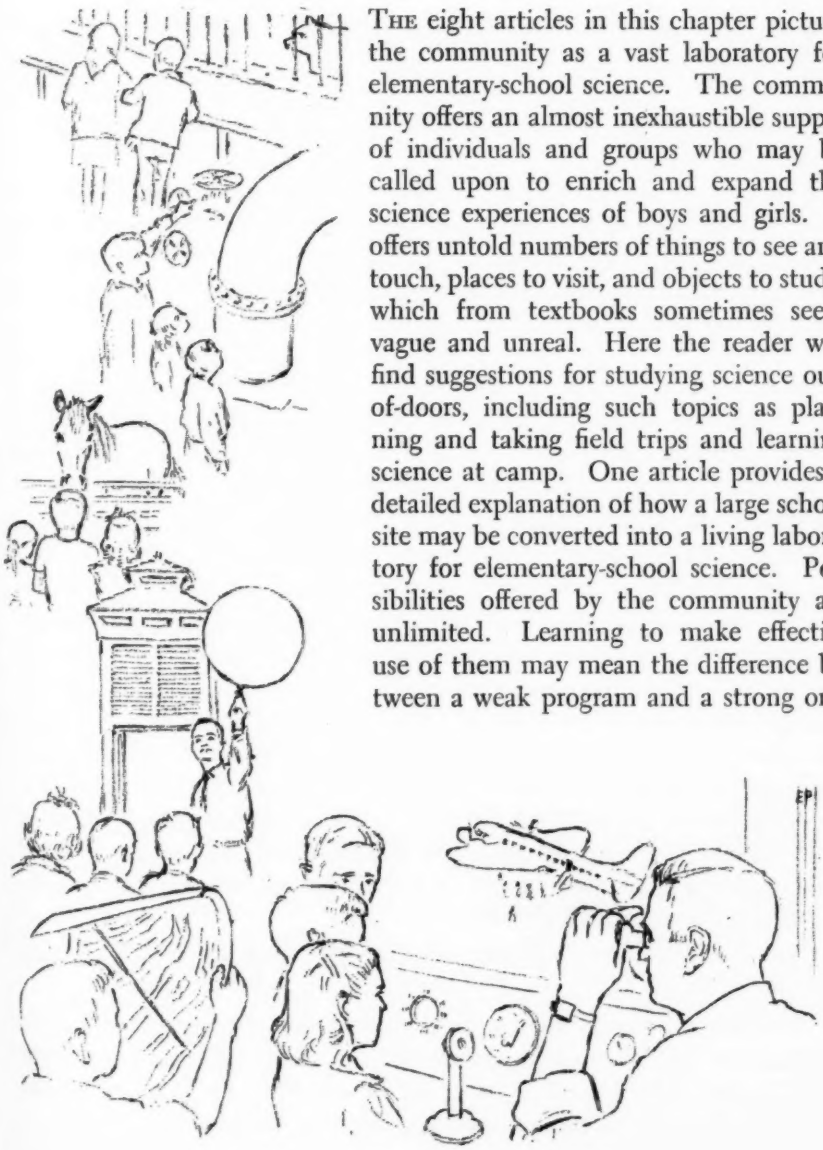
1. There was a direct carry-over from the summer classes to the following school year. One example was when a sixth-grade boy started a class project on bees which had been initiated the summer before when his class had visited some beehives at a doctor's home.
2. Children were given opportunities for self-expression.
3. Science had a new meaning.
4. Children became more interested in their environment thru direct contact with it.
5. Some found new interests which will make life fuller and richer in the years to come.
6. Some children developed science hobbies.
7. Cooperative planning carried thru into the whole school program.
8. There was more evidence of the scientific attitude in children.
9. Some children changed their attitudes toward school. No longer was it a dull place where one *had* to go; it was an interesting place where one *wanted* to go.
10. Teachers experienced great satisfaction from the real interest observed in the children.
11. Science had played the part of a "goodwill ambassador" between the parents and the school.

It is of the utmost importance that children understand the effect of science upon man's living. Not all the uses of science are beneficent. Science can degrade and destroy as well as advance and restore. The potential service of science to mankind is incorporated in the inscription on the National Academy of Science in Washington in these words: "To Science, pilot of industry, conqueror of disease, multiplier of the harvest, explorer of the universe, revealer of nature's laws, eternal guide to truth."

—WALTER F. DEXTER, "Foreword," *Science in the Elementary School*, California State Department of Education 1945.

CHAPTER SIX

Using Community Resources



THE eight articles in this chapter picture the community as a vast laboratory for elementary-school science. The community offers an almost inexhaustible supply of individuals and groups who may be called upon to enrich and expand the science experiences of boys and girls. It offers untold numbers of things to see and touch, places to visit, and objects to study, which from textbooks sometimes seem vague and unreal. Here the reader will find suggestions for studying science out-of-doors, including such topics as planning and taking field trips and learning science at camp. One article provides a detailed explanation of how a large school site may be converted into a living laboratory for elementary-school science. Possibilities offered by the community are unlimited. Learning to make effective use of them may mean the difference between a weak program and a strong one.

School Camp: An Ideal Science Laboratory

By JOHN D. WILLIAMS
Principal, University Elementary School
University of Wyoming
Laramie, Wyoming

AS PART of the inservice training program, the faculty of Foxpark School decided to visit some other schools. Mr. Guy, the sixth-grade teacher, visited the neighboring county school, Mountain View. He wanted to pick up some ideas that would help make science more interesting to children.

His first impression upon arriving at Mountain View School was that the day would be wasted. As he looked around, he saw children identifying rocks and leaf designs in plaster molds, reading maps, recording bird calls, and pressing herbarium specimens. He saw nothing that to him resembled an elementary-school science laboratory.

A LABORATORY IN THE HILLS

"Don't they teach school any more?" he breathed to himself as he remembered that he had reported in a recent statewide survey that the handicap that most hampered his science program was inadequate laboratory facilities. "Do you have a laboratory?"

"Yes," said Mr. Johns, the principal of Mountain View. "Miss Topliff, our fifth-grade teacher, will show you her laboratory."

"This is our laboratory," said Miss Topliff as she pointed to her busy students. "We have just returned from school camp. Last week our laboratory was in the recreation camp in the foothills of the Snowy Range Mountains, 30 miles west of town. The boys and girls and I spent five days in this outdoor laboratory because many science phenomena are best taught in their natural setting. We tried for many years here at Mountain View to teach elementary-school science from a book or from model specimens. It was worth the effort, but we have discovered that children remember longer and with less distortion those things which they see and experience."

"But I don't know practical science. We follow a textbook very closely."

"I didn't know very much science either when we started teaching it a few years ago. I learn with the children. I have acquired more insight into science since I have been going to school camp than in all the years of study in college and teaching from a textbook."

USING RESOURCE PEOPLE

"We use resource people from the community, too. Mr. Whittier, the science teacher from the local high school, came to conduct a field trip to study the geology of the outlying valley. He knows the history of the region and the valley formations very well. This was good follow-up on our unit, 'Our Changing Earth.' Sally invited her neighbor who has lived in the region for many years to visit the camp one night. He told exciting stories of early homesteaders and miners in the area."

LEARNING IS FUN

"This all sounds very interesting. Do you mean that I don't need a lot of expensive and elaborate equipment and that a school camp makes an ideal science laboratory? I have always thought of camp as a place for a good time."

"Fun it is. We do not teach formal classes in science but science is discovered, pointed out, and studied as children prepare meals, take nature excursions, sit around the camp fire, and talk in informal groups. Learning is fun and some fun is learning."

"What are some science activities which help make your school camp fun for boys and girls?"

Miss Topliff said, "Let's move over to the corner and let the fifth-graders share their camping experiences with us."

Jack Made Weather Charts

"Jack, you seem to be very much interested in weather charts. Did you make those at school camp?"

"Yes, Mr. Guy. My group set up a weather station. Before going to camp we visited the local weather bureau to study the various instruments used in predicting weather. Each day at camp we studied the weather and made the daily forecast in the camp newspaper. Now I am finding the average temperature for the week. The group will then compare it with the weather bureau reports for the same period and also with last year's camp report. Weather is important in our section of the country. We get lots of snow and we use our reports as one guide to selecting the week to go to camp. Miss Topliff, I think Mr. Guy would like to hear Bob's story about getting lost. He is working in the group across the room."

Bob Got Lost

Bob told an interesting story of how he had wandered by the wayside to observe ant hills and gopher holes while the children were on a late afternoon excursion to an abandoned silver mine. His interest in the

social habits of the large red ants lasted for 15 to 20 minutes, for he wanted some of the ants for his anthouse. He suddenly realized the group had gone ahead. "I do not know my way back to camp." He remembered the fifth-grade unit on magnets before they came to camp. Luckily, Bob had a simple compass in his pocket. "I need to go north. Which way is north?" His compass told him. The stars were shining brightly by now. Bob looked up at the Big Dipper; he looked for the Little Dipper. The North Star was easy to find. This also gave him a clue as to direction. Bob was very thankful that around the campfire the night before the entire camp group had had a practical lesson on "What can one see in the night sky?"

When Bob had finished his story, Mr. Guy was convinced that children need practical applications of science generalizations and fewer memorized facts and scientific principles.

LEARNING ABOUT CONSERVATION

"I'm sure you have described a full week of science experiences, Miss Topliff."

"On the contrary," she said, "that is just the beginning. Would you like to hear about our conservation activities?"

"Indeed," replied Mr. Guy.

"Conservation of both human and natural resources is important. Before leaving school each of us had inoculations and a complete physical examination. Our school nurse stayed with us at camp as the camp nurse. She gave us lessons in first aid. Under her direction, we were allowed to treat fellow campers for simple cuts and insect bites. On our pack trips, we knew what to do in case of an accident."

"Nutrition is very important in camp. In our health classes, we planned wholesome menus for meals prepared in the camp kitchen and made weight charts. Many of us gained weight."

"Mr. Cartwright, the forest ranger, talked with us about the wise use of our forests. He showed us how to tell the ages of trees, how to select trees for cutting, and films on the prevention of forest fires. His crew gave us a demonstration on stopping a forest fire. Mr. Cartwright and Mr. Jenkins, the county agricultural agent, directed a reforestation project on a burned-over hillside. This is now our school forest. We wrote letters to the state university and state conservation department asking for seedlings which were promptly sent to us."

FIRST-HAND LEARNING

Mr. Guy interrupted apologetically with the idea that the afternoon had slipped away and it would be necessary for him to be on his way

home. "I'm sure," he said, "there are many other science activities which enliven and enrich a school camping program. I would like very much to visit your camp next spring."

"Wonderful! We didn't have time to hear the children tell about their experiences in camp sanitation such as drainage, sewage disposal, water purification, dish washing, and preservation of food. But you will see that when you visit our camp next year."

"Before you go, Mr. Guy, I want to tell you about our first project," said Ned. "It was the most fun. We laid out and marked a mile-long nature trail. In this project we really learned the meaning of interdependence of plants and animals and balance in nature. Just reading about such things didn't mean much to most of us. We decided we wanted to participate in a conservation project. Some of us built check dams and planted an eroded hillside to hold the soil and make a home for animals.

"I remember another evening as we returned along the trail from a cook-out. Joe discovered a dragonfly flitting back and forth along the bank and among the rushes of a small stream. Listen! I hear Joe's group discussing this trip with Mr. Johns."

"Does the 'devil's darning needle' really sew up the mouths of liars, Mr. Johns?" asked Joe as he removed a dragonfly from the solution in which it was preserved.

Judy interrupted, "That is a snake feeder. My grandfather says they feed snakes."

Cook-outs can be used for practical lessons in science.
University Elementary School, Laramie, Wyoming

"Neither is true!" exclaimed Tom. "Those are only superstitions. The dragonfly is really beneficial to man. If we opened the dragonfly's stomach, we would find it loaded with flies and mosquitoes."

"I'll see if that is true," Joe mumbled to himself.

By this time, Jim had almost stepped on a toad that had escaped from the terrarium, and the attention of the group was attracted.

Lucy cried, "Oh!" as Jim bent over to pick up the toad, "Toads make warts."

"I don't believe toads make warts," said Jim. "I have handled toads many times. They destroy insects."

As Jim carried the toad back to the terrarium, Joe was opening the stomach of the dragonfly. Sure enough, there were some flies and mosquitoes. Mr. Johns told of his many experiences with toads on the farm. After examining his hands, the children were convinced that toads do not cause warts.

VISIBLE RESULTS

The nature trail provided many opportunities for morning walks. Bill learned to imitate 10 bird calls and Mary collected 21 different flowering plants for her herbarium which was placed in the camp museum. Rosa learned to identify the various types of trout in the stream. Rock collections appealed to Rex and Ray. They took the responsibility of labeling the rocks on the trail and collected extra samples for the museum. Later, these will be taken home, for both boys are developing collecting hobbies.

"Camp is fun; I wish we could have stayed longer."

"I want to be an astronomer."

"School has been more interesting this year."

"I want to be a camp counselor."

"We know our teacher better."

"I want to be a forest ranger."

"Everyone has a place in this world."

"I want to be a geologist."

Such comments made by the Mountain View fifth-graders as they worked kept running thru Mr. Guy's mind as he rode along in his car back to Foxpark. Science took on real meaning for him just as science had taken on real meaning for the boys and girls. After all, he thought, what happens to children as they scientifically work and think is more important than the number of pages they read each day.

"We may not be able to go camping for a whole week," he said to himself, "but next spring we are going to move our laboratory outside for some day camping."

Using the Community

By RICHARD L. WEAVER
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School of Natural Resources
University of Michigan
Ann Arbor, Michigan

MOST communities—small or large—are rich storehouses of resources available to the elementary-school science teacher. The use of these resources will provide the spark for a dynamic and interesting program.

INVESTIGATING COMMUNITY LIFE

In the Williston School of Wilmington, North Carolina, the classroom teachers, principal, and students undertook an intensive study of Wilmington. Various classes volunteered to investigate different aspects of community life. One child, whose father worked on a merchant ship, brought in some coffee which was being shipped on her father's boat. This led to further inquiries about imported items, their origin, and their destination. It was discovered that many other fathers were employed on ships bringing in some of the ingredients of fertilizers, oil from the Gulf states, and numerous other things. Being a fourth grade, they relied largely on information provided by parents; but for older children a little added research would easily expand the study into many fields of interest. Certainly geography, science, mathematics, and history could all be woven into an integrated story.

Art, music, and crafts were used to tell their story to the other classes in a schoolwide open house and teachers workshop. The principal, being an excellent photographer, took numerous kodachromes of the activities, which were used in the teachers workshop.

Another class became interested in the fishing industry of the area. They visited the fish markets and fishing boats, again relying heavily on information from parents working on the boats. Over 20 species of fish were found to be of economic importance in the area and the children learned to identify them and the purposes for which they are used.

In the Forest Hills School of Wilmington, a second-grade group made a large mural of the school grounds and located all the trees on it in relation to the school building. The children learned the kinds of trees and discussed which ones they could add in order to improve the school grounds as an outdoor study area.

SCHOOL GARDEN PLOTS

At the Wrightsboro School in New Hanover County, near Wilmington, in the center of a thriving bulb industry, a school garden, in which various kinds of bulbs are grown, has been maintained for 12 years. Most of the bulbs are provided by parents who grow them commercially. A contest each spring among the 10 classes in the school keeps up a lively interest in gardening, new fertilizers and insecticides, and cultivation methods. Experimental station employees nearby gladly serve as advisers when needed. I arrived one morning at 9 o'clock and three children were "breaking out" a new garden plot. I inquired about it and was told that the school had been allotted a new teacher, so they needed a new plot. You can't teach in Wrightsboro School and not have a garden.

BUILDING COLLECTIONS OF MINERALS

In a seventh grade at Garner School in Wake County, North Carolina, where students were encouraged to choose their own units of study, six selected rocks and minerals as their six-week unit. The teacher provided them with initial sets of rocks, samples of specimens she had collected. She suggested that they try to increase their own collections and to find cigar boxes to house their collections. Soon one boy asked if the class would like to visit his father's stone-cutting establishment. Of course, they wanted to go, and the trip was arranged. The father described the various marbles and granites, told them where he obtained the stone, and gave each of them chips of the different rocks. This experience aroused so much enthusiasm that many more students began collections and later selected the study of rocks as their next unit.

Most public buildings are trimmed with some form of rock. Tracking down the origin, the peculiar characteristics, and the reasons for using particular kinds would be a good group or individual project in any town or city.

PLANNING SCHOOL TRIPS

When a teacher and her eighth-grade class in Salisbury, North Carolina, were making preparations for a school camping experience, special committees were established to do certain things for the class on the way to and from the camp. The camp was located 60 miles from the school, and the trip was planned so as to include as many worthwhile observations enroute as possible.

A committee on agriculture made plans for observations of the kinds of crops being raised, the changes from one county to another, and

so on. The committee on geography mapped out the route and was prepared to point out the rivers, mountains, and county seats and other towns they would see. The housing committee prepared to study the kinds of architecture, new building materials being used, and changes in styles from one town or county to another. Another committee planned to see how well farm machinery, barns, yards, and fences were cared for.

A wildlife committee prepared to observe the animals. The historical committee looked up the best places to stop to see churches, graveyards, and courthouses of special historic significance, and prepared to pass on important information to the others at these spots.

USING PUBLIC RECORDS

In cities, county seats, and many of the larger towns, the extent of information in courthouses and municipal buildings is unlimited, and in many cases hardly used by our schools.

In Fayetteville, North Carolina, where I conducted a workshop on resource-use education, the 30 teachers and I visited the health center where we asked the staff members to answer some interesting questions. We wanted to know:

1. Which diseases are found most frequently in the county?
2. What should children know about these diseases?
3. How can the schools help the health department reduce disease in the county?

The answer to our first question was: "Venereal diseases are two or three times as prevalent as any other, and the county incidence of venereal disease is higher than in any other county in the state." Intestinal parasites ranked second, and most of the information on this subject was entirely new to this group of teachers.

It soon occurred to us that if we were going to have students study health in Cumberland County, we would have to increase the emphasis on the diseases most prevalent and look for more specific information on the parasites responsible than we could find in our textbooks. In fact, the health department staff and local doctors seemed the logical and most important source of such data.

In another workshop we became interested in interpreting some of the early land-use patterns of the county from local deeds and wills. Such records are public property and are kept in courthouses. The earliest ones included much information on the kinds of trees of the area; the farm equipment used and passed on to the next generation, and even the crops raised; the kinds of materials used in the buildings; the amount of cleared and uncleared land; and the relative index of the level of living for the period.

Many boys and girls graduate from school without ever having examined a real deed or will. Very few know how such records are preserved and filed. Recorders and registrars are usually quite willing to spend time showing a group of school people how such things are handled, and helping them find specific information.

DEVELOPING A 20-ACRE SCHOOL SITE

In many cities and in some rural areas where consolidated schools are being built, school administrators are embarking on a somewhat revolutionary idea—that of having a school site large enough to provide numerous learning experiences in science nearby. Such sites of 20 or more acres can provide an outdoor laboratory with varied experiences, such as some of the following:

School Gardens

Some schools have suitable areas which can be devoted to garden plots for growing vegetables, bulbs, and flowers. Thus, each class can have an individual plot. Contests between classes often create interest. Produce can be used by the school, taken home by pupils, or sold. Flowers for decorating the school can be grown. By choosing vegetables which will mature early, most of the value of the garden can be achieved before school closes. In some cases children near the school can take care of later maturing varieties after school closes. It is worthwhile for children to learn how to prepare soil for planting, how to select suitable varieties, and how to plant and care for their growth. Home economics classes can demonstrate proper preserving methods. Much about proper gardening, learned at school, can be valuable at home.

Starting Plants in the Classroom

Seeds and cuttings of many vegetables and house plants can be grown in the classroom during the winter and spring months and placed outside in appropriate places on the school ground during the summer, or sent home to be cared for by pupils during the vacation periods. The closer the school gardens are to the classrooms the better, as more attention can be given to them.

Growing Shrubs and Trees

A rooting bed can be made by enclosing an area with brick, stone, or tile block, filling it with clean washed sand, and covering it with strips of wood to cut down the amount of light. Cuttings of most shrubs can be rooted in this bed by placing pieces of the stems in the sand during the late summer and keeping the sand well watered. The

shrubs can be removed when rooted and planted in appropriate places, or hardened in other beds where some fertilizer can be added to stimulate growth before finally locating them in permanent positions. Some schools have grown enough shrubs to landscape the entire school site.

Tree seeds can also be germinated and seedlings can be transferred to beds for later use in landscaping. Such trees as poplars and willows will also grow from pieces of the stems placed in the rooting bed. The rooting beds should be as near the agriculture department or school building as possible. A convenient water supply is obviously essential.

Wildflower and Rock Gardens

The more rugged areas of the school site can often be set aside for planting wildflowers and the development of rock gardens. Plants can be transferred from the region around the school and cared for in such gardens. These can be labeled and their relative abundance observed.

Tree-Growth Demonstration

Tree growth can be studied by obtaining the ages of various trees with an increment borer used by foresters. The age can be included in the name labels. Posts and logs often used around parking areas and playgrounds will also show annual rings, in which case comparative studies are possible. Sections of older trees can be obtained and preserved when such trees have to be removed on or near the school grounds. Occasionally stumps can be preserved in place. The date of cutting should be recorded on them so that historical events in the community can be related to the growth of the trees.

Campus Arboretum

The campus should have as many species of local trees and shrubs on it as can be integrated with the plans for playground space. These should be labeled so that children and teachers can identify them and make comparisons with nonlabeled trees elsewhere. Various classes can add needed trees as class projects and as a culmination activity for tree study.

School Forests

Since many school sites are not large enough for some of the above projects, other areas can be secured for the development of projects not possible on the school property. These areas should be as near to the school as possible to facilitate use. They can be developed as school forests where many valuable teaching demonstrations and work experiences are possible. Planting, thinning, and selective cutting of trees are easily taught on these areas, along with erosion control, fire pre-

vention and control, values of various species of trees, succession of forest types, natural planting, and production of forest by-products like Christmas trees, posts, and firewood.

Such school forests should include as many of the features suggested above for school grounds as cannot be conveniently located at the school itself. Help can be obtained from the state division of forestry, the U. S. Forest Service, and the forest experiment stations.

Legislation has been passed in some states making it possible for boards of education to purchase or accept ownership and control of areas for school forests. The information on a particular state can be secured from the state department of public instruction or the state department of conservation.

Wildlife Sanctuary

The whole school ground can be designated as a wildlife sanctuary and certain things done to increase the number of birds and mammals which will visit or make their homes on it. Planting Lespedeza bicolor and Multiflora rose, obtainable from the state conservation departments, will supply food and shelter for many species of birds. Developing thickets, brushy fence-rows, and allowing certain areas to "go wild" will supply additional food and shelter. Weeds permitted to grow in the garden during late summer months will produce food in the fall months for sparrows, goldfinches, and other seed eaters.

Birdhouses, especially for bluebirds, can be built and placed about the grounds. These need to be single-holed houses placed in open areas, as bluebirds usually will not nest under trees. Plans for suitable houses for all hole-nesting species can be obtained for 25 cents from the National Audubon Society, 1000 Fifth Avenue, New York City.

Feeding shelves and trays and drinking fountains for birds can be placed at or near classroom windows where birds can be studied closely by all pupils. Such things as sunflower seed, millet, stale bread and doughnuts, and suet will be eaten by 15 to 20 species of birds. Feeding devices do not need to be elaborate and, if kept well stocked with food, birds will usually find them and continue to use them. Some shelter in the way of trees or shrubs near these feeders will increase their use.

Many berry-producing, bird-food shrubs can also be used in school landscaping, such as pyrocantha, mountain ash, dogwood, eleagnis, sumac, and viburnum.

Bog Garden

If the school is located in a suitable place, a small stream or spring can be dammed so as to provide a bog garden where aquatic plants and animals can be placed for observation and study.

Fish Pond

If water is available for a fish pond, fish can be raised and made available for study. The use of fish as fertilizer, the effect of predatory fish, and many other valuable lessons can be illustrated. If a natural water supply is not available for a bog garden or fish pond, it might be feasible to use the school's water supply and pipe it into such areas.

Turtle Pit

In a few instances a school may want to develop an area for temporary housing of reptiles such as turtles, snakes, and lizards. This area, of course, should have a water supply and fencing adequate to keep the animals from escaping and the children from falling into it.

Erosion Control and Soil Study

Most school grounds and surrounding areas are susceptible to erosion because of the intensive use of small, crowded areas. Certain soil-holding plants like lespedeza, kudzu, and honeysuckle can be used to help improve this condition in areas where their excessive growth can be controlled. Various devices, too, can be installed to assist in checking the flow of water, such as terraces, diversion ditches, runways, and the like. Such work can be done by the children and kept as a permanent exhibit for teaching purposes. Small run-off demonstrations can be set up to show the relative effectiveness of different kinds of ground cover. Banks can be exposed in such a way as to demonstrate topsoil and subsoil. A soil auger can be used for such demonstrations in other areas.

Nature Trails

A nature trail can be developed on many school grounds or in school forests. The trail should take in most of the kinds of habitats available. Signs can be used to identify the various plants and animals and to tell interesting facts and stories about them. The research required to secure the needed data, the making of the signs, the art work, and the correct grammar and spelling make the development of such a project a unique method for obtaining cooperative action of staff and pupils. Advice on planning such trails can be secured from the National Audubon Society.

Weather Stations

The erection and maintenance of a weather station on the school grounds will be of great interest to many pupils. Regular rainfall and other data can be recorded and posted on the school bulletin board by various committees and classes. Directions for developing a weather

station can be secured from the nearest U. S. Weather Bureau office. Since the equipment of a weather station must be protected, it can be erected in the patio or a courtyard which can be fenced off and locked. The same precaution would apply to the turtle pit, small fish pond, bird bath, and bird feeders.

Outdoor Classrooms

Placing some logs or stones in a circular position in a suitable spot on a hillside will make it possible to have a classroom outdoors for use in warm weather. These areas can be screened off with cedars and other evergreens so that considerable privacy can be secured.

Picnic Area

A fireplace with appropriate seats of stones or of logs can be erected in an area for outdoor meals and class get togethers. These can also be screened from other areas by evergreens.

Outdoor Theater

If suitable ground is available, an outdoor theater for plays, singing, and commencements can be developed. Sloping ground facilitates such plans. Streams or ponds can be utilized for scenic effect.

School Camps

Some schools are finding it desirable to have children camp outdoors for a week or more to study nature, conservation, forestry, soil and wildlife management, geology, and related topics. Schools can use public and private camp sites already available, but some will want eventually to own their own sites for such instruction outdoors.

Fields for Crops and Horticulture

The demonstration fields for agriculture and horticulture need to be as near the classroom and shop as possible. Pasture plots, seed-testing areas, tree nurseries, and vegetable and tobacco plots can be developed for study and practice.

PLANNING

These suggestions, of course, are incomplete. They do offer, however, infinite possibilities for the alert administrator and faculty. Education, we must remember, cannot be confined to classrooms.

A Master Plan

Before too many of these suggestions are initiated, it would be desirable to develop a master plan for the school grounds which would

cover short-time objectives and also the long-range planning for the property. Locations of future additions to the building and to athletic grounds need to be considered in order to avoid costly changes later.

The total plan for the school property should include the trees and shrubs needed for improving the appearance of the building and for helping to define the various play areas, walks, outdoor demonstration areas, and parking space. Each piece of property, of course, requires special treatment to capitalize on the contour of the land and the peculiar features of the buildings or particular requirements of instruction. Many times shrub screens and attractive hedges can be used to separate various areas or to hide unsightly spots adjacent to the school grounds. Trees take a long time to grow and their planting and removal need to be studied very carefully and fitted in with the long-range development of the property; therefore, the combined thinking of administrators, maintenance personnel, and instructional staff, plus as much professional help from landscape architects as possible, is needed to perfect a satisfactory over-all plan.

Help on landscaping can be secured from such sources as local nurserymen, the state highway commission, the state department of public instruction, and the state extension service.

Community Cooperation

Even tho one teacher can do some of these things alone, it is well to use all the resources of the professional staff and to invite cooperation from all sources available. Such sources would include maintenance men, the custodial staff, parents, local nurserymen, and representatives of such agencies as the Soil Conservation Service, the state conservation department, and the state extension service. Full and effective development demands communitywide thinking, planning, and action.

A much more varied pattern of recreation is an urgent need of our nation today. The outdoors provides almost infinite possibilities for it. The problem is that of opening up the possibilities to a larger segment of the population and of teaching positive, creative use. Certain skills, habits, and attitudes are essential before people can make full use of what the outdoors offers. Acquiring them is not an overnight job. They should be lived to be learned. A children's camp, staffed with persons skilled in the work of the woods, can make an effective contribution.

—GEORGE W. DONALDSON, *School Camping*, Association Press, 1952.

We Learn To Identify Trees

By FRED S. SCHNELL
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SHEBOYGAN is noted for its beautiful trees and spacious as well as popular parks. In fact, it is generally known as the "City of Elms." Trees are everywhere; they beautify the homes, provide comforting shade during the heat of the summer day, and give character and life to the landscape.

It is, therefore, only natural for the school to teach its children and youth to identify, know, appreciate, and become interested in its trees. At the same time, the school is attempting to give the boys and girls social experiences that may be equal in value to the knowledge of science it seeks to impart.

REASONS FOR STUDYING TREES

Initial work in teaching the pupils to identify the most common trees of the locality was begun 20 years ago when a planning committee consisting of the park superintendent, the director of elementary education, classroom teachers, and principals organized a program of tree identification. This program was started with several major purposes in mind: (a) to instil a love and appreciation of nature; (b) to identify the different trees by their leaves, bark, flower, and fruit; and (c) to decrease vandalism and destruction in the local parks and along the boulevards.

The program passed thru many stages of experimentation and development until today the plan in operation includes a resource unit, a tree-identification booklet, class laboratory work, and two field trips to the parks.

A RESOURCE UNIT

A science bulletin, "Tree Identification," is a resource unit compiled by the science committee of teachers and principals to guide classroom teachers. It is one of the first units for the 12- to 14-year-olds and is scheduled for the first three weeks in September when Indian Summer favors our region with pleasant weather. The bulletin is helpful because it gives the teachers detailed information on the nature and scope of the unit. It explains how to use a tree-identification booklet and how to take care of samples of branches and leaves. It also contains schedules

of park assignments for field trips and teaching suggestions based on past experience. Changes and suggestions submitted by teachers make it possible to bring the bulletin up to date annually. It is issued to teachers during the first week of school.

USING A TREE-IDENTIFICATION BOOKLET

At the beginning of the unit each pupil is given the booklet, *Summer Key to Forest Trees of Wisconsin*.[1] This booklet, compiled by the park superintendent, gives a detailed description of the various leaves and trees. During the first few class sessions the pupils are guided by the teacher to note the characteristics of the leaves. They are asked to examine a particular specimen and note its shape, size, and color; its petiole; the bluntness or sharpness of its serrations; and other distinguishing marks of identification. When these identification features have been observed, the pupils are asked to turn to their tree booklets and find the description of the leaf which best fits the leaf they are studying.

The following are among the trees described in the booklet:

Jack pine
Tamarack
Balsam fir
Hemlock
Black and white spruce
White and red cedar
Basswood
Slippery elm
American elm
White beech
Balsam
Poplar
Red, bur, and white oak
Choke cherry
Red mulberry
Mountain ash
Box elder
White ash
Walnut
Silver, red, and sugar maple
Ironwood

Experience has shown that only one or two illustrations by the teacher are necessary before the pupils are able to identify certain trees using the tree-identification booklet, and within a surprisingly short time they learn to identify most local trees found on the way to and from school and in the parks.

FIELD TRIP

After the preliminary study in the classroom has been completed, the pupils and teacher go to a park assigned to the class by the park superintendent. At the park foresters take the pupils in groups of six or eight over a trail previously marked. Along the trail the forester names the trees, points out the distinguishing features of each, and asks the

[1] Rayner, G. Z. *Summer Key to Forest Trees of Wisconsin.* Sheboygan, Wis.: Zimmermann Printing Co., 1949. 4 p.

boys and girls to note in their tree-identification booklet, which each has brought along, the description of the specimen under discussion. This method of presentation has proved effective, for when the group comes to similar trees in different areas of the park, most pupils can identify them. At the end of an hour-and-a-half period in the park, 25 or more trees have been classified and discussed.

EVALUATION

A week after the first field trip the boys and girls again are taken to the park, but this time the object is to test their knowledge. The pupils are required to identify 25 marked trees along a given trail. The foresters and teachers accompany them on the trail and direct them to the different trees. All work is done independently; however, they are permitted to use the tree-identification booklet if they wish. A form like the following is given to each pupil at the beginning of the trail.

SHEBOYGAN PUBLIC SCHOOLS

TREE-IDENTIFICATION TEST

1. White pine
2. Norway pine
3. Balsam fir
4. Hemlock
5. White spruce
6. White cedar
7. Hawthorn
8. Tamarack
9. Box elder
10. Silver maple
11. Red maple
12. Sugar maple
13. Black ash
14. White ash
15. White beech
16. Mountain ash
17. Pin cherry
18. Choke cherry
19. Black cherry
20. Blue beech
21. Paper birch
22. Yellow birch
23. Black birch
24. Aspen popple
25. Cottonwood
26. Butternut
27. American elm
28. Black walnut
29. Ironwood
30. Bur oak
31. White oak
32. Red oak
33. Basswood
34. Red mulberry
35. Red cedar
36. Jack pine
37. Shagbark hickory

Directions: On the left side of this sheet are listed the names of the common trees of Sheboygan. From this list select the one which you think is the one represented in the test and indicate its name by the *number only*.

A. ( )
B. ( )
C. ( )
D. ( )
E. ( )
F. ( )
G. ( )
H. ( )
I. ( )
J. ( )
K. ( )
L. ( )
M. ( )
N. (
O. (
P. (
Q. (
R. (
S. (
T. (
U. (
V. (
W. (
X. (
Y. (

It is interesting to note that most boys and girls are able to identif the majority of the trees. The city average for all public schools is rathe high. Furthermore, the entire tree-identification program is always antic ipated with much pleasure by all seventh- and eighth-grade pupils fo as explained earlier, it teaches science in nature's laboratory.

Learning about Rocks Together

By JESSIE B. WALKER
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OUTSIDE the classroom the September sun shone brightly; inside a storm seemed to be brewing—teacher against fifth-grade pupils in a battle of wills.

"I think we should start our study of science this year by learning about rocks," Lee announced firmly.

"But, children, don't you think it would be fun to find out what happens to trees and other plants when autumn comes?"

"Of all the things we have listed, I think learning about rocks would be best," Carolyn backed Lee up, while the others nodded.

One last attempt: "How many think it would be interesting to learn about insects first?"

All hands remained down.

"Well"—bowing to the inevitable—"how many want to start with rocks?"

All hands went up and smiles returned to their faces.

STARTING FROM SCRATCH

Thus I began the year with a subject almost totally unfamiliar to me. Since I knew almost nothing about rocks, I had been hoping for a reprieve while I did some studying and planning before starting this particular unit. Not only was I unprepared to teach it, the children had had few science experiences prior to this time. To make matters worse, they had never been given an opportunity to do pupil-teacher planning or to work in small groups in solving a problem. It was really starting from scratch for all of us.

The reason—and a good one it was—for their insistence upon studying rocks first was that their entire lives had been influenced by the presence of large granite formations in our community. We live in a quarrying section of the state, not far from Stone Mountain. The only industry of any size in our rural community is a granite quarry, where the majority of the men work. Why shouldn't my class be interested in rocks?

We began by listing on the board the things they wanted to find out about rocks. Such difficult questions! It seemed to me that only a

geologist could answer them. I had been "exposed" to geology for all of six weeks, and even that was a long time ago. Some of their questions were:

1. How were rocks formed and why are there so many different kinds?
2. What kinds of rocks are found in our community, state, and nation?
3. How were the limestone caverns formed?
4. What causes wood to become petrified?
5. What are the uses of rocks today and how were rocks used in earlier days?
6. What causes rocks to break and crumble?
7. What are fossils? What caused them?

ORGANIZING FOR GROUP WORK

The questions were divided into four groups, and the children formed themselves into committees in which they wanted to work. The class president acted as chairman, and each group chose a recorder and a reporter.

They listed sources of data and activities for finding the information they wanted. These included:

1. Sources
   a. Books: textbooks, library books, reference books
   b. Films and filmstrips
   c. Resource people
      (1) Executive of the quarry, an authority on rocks
      (2) State geologist
      (3) Instructional supervisors
   d. Magazines and newspapers, especially copies of *National Geographic* on file in our library
2. Activities
   a. Making maps showing places in state and nation where quarrying is done
   b. Making a display showing the composition of the granite in our quarry
   c. Field trips to
      (1) Large exposed rocks near the school
      (2) The local quarry
      (3) Stone Mountain
      (4) A cutting and polishing shed
      (5) The state capitol building to see rocks and minerals on exhibit there
      (6) A stream nearby to see the effects of water on rocks

WORKING TOGETHER

For some days the class was busy getting together the materials for working on the problem. All the science textbooks in the school were

examined and when one was found that had something in it about rocks, it was borrowed, whether it was a primary or an upper-grade book. (One of the best possible recommendations for this method of work is that in this framework it is easy to provide something that is challenging for every child to do on his own level. The child who finds his information in a primary book feels he is contributing just as much to the class as the one who uses a standard reference book.) The school library was examined for books and pamphlets on the subject and the county librarian was told what we needed. The audio-visual catalogs of both our county and state libraries were searched for films and filmstrips and orders were prepared for the ones we thought might be helpful.

Contacting Resource Persons

The class wrote a letter to a local citizen who is an authority on rocks, asking him to talk to the class. They also wrote to the state geologist as well as to the manager of the quarry. In each case everybody wrote a letter and the class decided which one should be mailed.

Using Films

Several films came right away. One of them, *The Earth's Rocky Crust*,[1] proved to be just what we needed. After we had seen it once and discussed it, the class thought we should see it again. In all we saw this particular film three times. The other films also were studied and discussed. Sometimes a committee of children would preview the film, make the necessary plans for the class to see it, and finally, direct the follow-up treatment.

The Local Expert

When the expert on rocks visited us, he brought specimens of many different kinds of rocks, some books, and other materials he thought would be helpful to us. He also brought some jewelry he had made of stones found in the quarry. The children were fascinated; in fact, his visit was one of the highlights of the year. He was able to tell them many interesting things about the geologic age and about the origin of Stone Mountain and our own smaller mountain. He also identified many of the rocks in our collection for us.

Field Trips

The eagerly awaited trip to the quarry lived up to expectations. We were able to watch every operation from drilling the stone preparatory

[1] *The Earth's Rocky Crust.* 16 mm, sound, black and white, 11 min. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill. 1943.

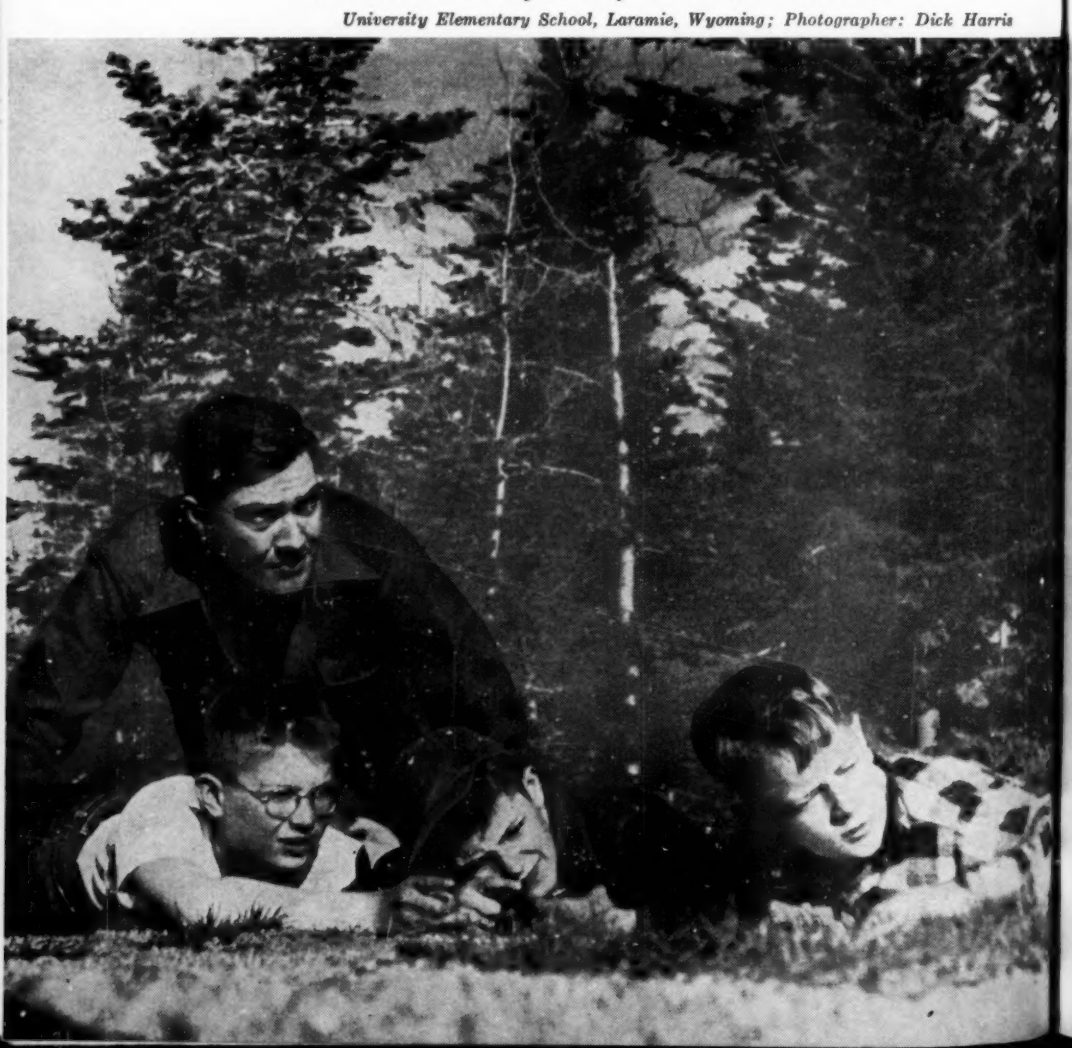
to blasting to the loading of the crushed stone on trucks and railroad cars. Later we saw a color film showing the same operations and we found it especially interesting for several reasons. For one thing, we could test our memory to see how much we remembered of what we had seen earlier.

From the geologist we learned that we could get an exhibit of 78 rocks common to our state if we could provide a display case for them. We did this and the entire school is now enjoying the exhibit.

We were able to see the effects of weather on the large exposed rocks near the school as well as other ways rocks are broken up and crumbled until they become soil. The class was greatly impressed when we found a slender tree growing in a crack in a huge rock, with the crack being widened as the tree grew.

We used our compass to find North and South.

University Elementary School, Laramie, Wyoming; Photographer: Dick Harris



The other field trips were made and much reading and studying went on in the various groups before the time for each to report to the class. Maps and charts were made to show some of the things they had learned and these were used in reporting. Only one group reported on any day, so there was plenty of time for questions and discussion. Sometimes the questions could not be answered; this called for further research because we resolved never to leave a question unanswered.

BYPRODUCTS

At the conclusion of the unit the children agreed that it was more fun than anything they had ever done. When we evaluated the work, they thought we had failed to follow thru on some things we planned to do, but, for the most part, we had accomplished our objectives.

A visiting teacher from another school system asked how we managed to get this work done without neglecting the tool subjects. This led to an evaluation of what we had really been doing. The children had been doing more reading than ever before, because they were doing it for a purpose. In addition to the usual spelling lessons we had made our own word lists, learning to spell and use the words which we were meeting so frequently in our study. I learned at this time that the seeming difficulty of a word had nothing to do with whether the children learned to spell it if they had a reason for wanting to learn it. Because there were so many letters to write, they learned a great deal about letter writing. As they searched for information about locations of various types of rock, they were learning geography. The charts, maps, posters, and various displays provided many opportunities for creative expression. As they talked with visitors and made field trips, they were learning and using certain social skills which they needed badly.

OUTCOMES

Altho the outcomes are not easy to enumerate, these should certainly be included:

1. Greater enjoyment of, and skill in, pupil-teacher planning
2. A greater knowledge of how to work in small groups and how to share the results of group work with others
3. A keener interest in classroom work on the part of slow-learning children
4. An expanded understanding of community life and community work
5. Improvement of research skills of pupils
6. A greater awareness of, and interest in, the local physical environment
7. A greater interest in the school program among the laymen in the community who helped us
8. A new willingness on the part of the teacher to try something new and different in her classroom.

Science in Camp

By JOHN STEVENS
Principal, Tekoa Elementary School
Tekoa, Washington

and GENE CRAIG
Principal, Henry Ford Elementary School
Renton, Washington

THE purpose of this article is to show what science learnings can be acquired in an organized outdoor-education program. The science phase, however, is just one of many values to be gained thru camping. It is hoped that administrators and classroom teachers will be able to see that making use of the out-of-doors is almost mandatory.

For the past three years the Auburn, Washington, public schools have operated a camp during the school year for their sixth-grade pupils. Each class moves to the island camp for a period of one week. The writers have had many opportunities to observe a great variety of science learnings during these periods. No one group of children received all the experiences to be mentioned, and oftentimes these outdoor learnings were but an extension of some phase of classroom work. Each week various projects were undertaken, depending on the interest of the children and the leadership. People tend to do their best teaching when they are interested in the subject.

LEARNING ABOUT WEATHER

When the buses unload at the camp, the first questions are likely to be: "When may we go swimming?" and "May we camp out tonight?"

Questions such as these offer the skilled leader a basis for talking about the weather. The discussions have included the types of clouds, their color, height, direction of their movement, cloud sequence, local geographic features affecting the weather, and past records of weather for that time of year. Present weather observations are recorded.

When a group planned on sleeping out, two important weather problems to be considered were the choice of a sleeping area in relation to the fire and smoke problem, and whether the weather favored sleeping under the trees, in the open, or under "tarps." Stories of Indian weather lore and discussions of animal and plant weather signs completed the evening's campfire program.

Because weather affects all plants and animals, all phases of nature study—forestry, soil composition, conservation, and plant and animal life—are interrelated.

STUDYING TREES AND PLANTS

A ranger from the state forestry department served to heighten the children's interest in trees, their products, tree identification, prevention of forest fires, and the conservation of this valuable resource. Class members helped choose a tree which was ready to be cut and were instructed on how to fell the tree. Under the direction of the ranger, the youngsters actually cut down the tree. The rings were counted and the probable causes of the differences in growing seasons were brought out. The tree was then cut into firewood. By this lesson the sixth-graders learned that timber is a crop, and if it is not harvested it will be wasted. The ranger pointed out trees that had been abused by inconsiderate people. When a tree was found that was damaged by disease or insects, it was called to the attention of the group.

The instructors often continued this study further, going into plant identification, why plants grow where they do, what kinds of soil are necessary, how plants reproduce, and their value. The children discovered that "dirt ain't just dirt!" Scrapbooks were often kept of the various species of trees and plants. These scrapbooks contained actual leaves or sprayed or crayon-rubbed leaf prints. The pupils found that mats for their cabin floor could be woven out of cattails. Usable brooms were made of ferns and evergreens. Some of the plants were found to have food value, such as the various berries and even the lowly cattail with its edible portion.

ANIMALS AROUND CAMP

The fauna of the island where the camp was located always aroused the interest of the pupils. The state game department was most helpful in bringing pelts, stuffed animals, and birds for the children to examine. A hike around the island showed the presence of a variety of animals. It was not necessary that the children actually see the animals to know that they were present. The beaver leaves his distinctive mark on a stump, and partially eaten shrubs indicated that deer were near. On one occasion a buck and doe were seen. An osprey's nest was located with the aid of binoculars. The mountain beaver's holes were ever present. A live animal trap was baited and several mountain beaver were caught. After they were studied, the animals were given their freedom. An understanding of the balance in nature was gained upon observing the remains of a robin which had been partially eaten by a weasel.

Different types of insects were seen and identified. First-hand experiences with insects are not always pleasant, as a girl learned when she stepped into a yellow jacket's nest.

Frogs thrived in the marshy inlets of the lake. Not all varieties of fish

abound in the lake since it is a man-made lake and when the water level drops, eggs which have been laid along the shore are killed. However, bass, perch, crappie, and carp were caught by the children. One counselor used a knowledge of the habits of the male large-mouth bass to catch the fish with just a hook. The male bass is known to attack anything which might endanger the nest, and the counselor merely held the hook on his finger and snagged the fish as he charged.

ASTRONOMY

Sleeping under the stars increases the child's awareness of the heavens. Often this was the child's first opportunity to be with someone who knew something about astronomy. This phase of science is most difficult to teach in the classroom, as young children are unable to make the observations at night. Their knowledge was increased by the aid of a telescope and star maps. Ancient legends about the sky and the constellations were told around the dying embers of the campfire.

HEALTH AND SAFETY

Camp-outs and problems of sanitation were closely related, as proper precautions had to be taken regarding sewage and garbage disposal. Each group was responsible for setting up and maintaining adequate sanitary facilities.

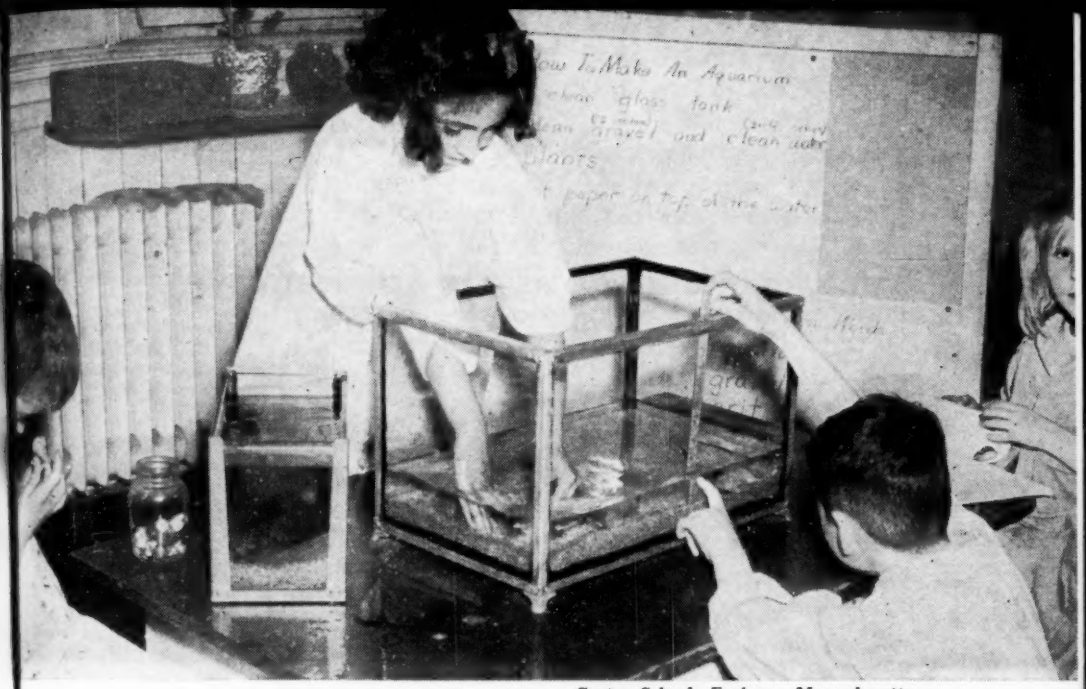
In camp the pupils learned about the chlorination of water and why it was necessary. A disinfectant was used whenever the dishes were washed. They learned that garbage could create a real problem if not properly disposed of. The children often helped to dispose of the garbage. Good health habits were practiced daily.

First-aid instruction was given by the school nurse and all classroom teachers were qualified "first-aiders." Children soon learned to nurse their own minor insect bites, sunburns, cuts, and scratches.

The sixth-graders were responsible for selecting their own menu when arranging for a cook-out. Points to be considered included the nutritional value of the food, ease of preparation, equipment needed for its preparation, and the weight of the food if a hike of any distance was involved.

ELECTRICITY

The children were shown the gasoline motors that generated the electricity, which ran the water pumps, ran the refrigerator, supplied the lights, and operated the fans on the kitchen stoves. Another potential form of electricity was present in the man-made lake since it served as a reservoir for a power plant. Flumes bringing water into the lake



Center School, Fozboro, Massachusetts

The children enjoyed building their own aquarium.

were seen by the children. The level of the lake was seen to fluctuate as the demand for power varied.

SWIMMING AND BOATING

The matter of buoyancy was considered when the sixth-graders were taught swimming. The children were anxious to go boating, but an understanding of buoyancy and stability helped them understand why safety in boats is so necessary. All nonswimmers had to be accompanied by a counselor who could swim, and the child had to wear a life preserver. The way a life preserver works was discussed thoroly.

GAINS JUSTIFY EFFORTS

While many of the science learnings were peculiar to our particular area and situation, there are numerous opportunities in any outdoor program. It may be an hour's hike, a day-long excursion, or an extended outing like the one in the program described.

Enthusiastic leaders are the key to a successful program. The science learnings account for only a part of the total gains, yet they alone would justify the effort necessary in carrying on an outdoor-education project.

The Community Was the Laboratory

By ANNICE DAVIS ELKINS
General Supervisor
Osceola County Schools
Kissimmee, Florida

WHAT you would learn—teach! This probably applies more to science than to any other subject in the elementary school. Few teachers at this level majored in science. Good teachers learn with their pupils. In science the door is wide open for the alert teacher.

Such thoughts ran thru the mind of one sixth-grade teacher as she planned for the opening of school. In years past *she* had planned *what* units would be studied with little thought of *why*. She saw to it that there was balance in the six major areas of science. That was easy, for the textbook did it for you.

This was a new year and she had a new idea. Why not give the children a chance to say what *they* were interested in and what *they* would like to investigate? Would it work? Could she tie their interests down to six or seven large units, spread over the six major areas so important in all elementary-school science literature? Could they find the information they would need? It was worth the try. She had faith in the democratic process of decision-making, even among sixth-graders.

EXPLORING SCIENCE INTERESTS

Preplanning for this venture was exacting. For instance, where could they find first-hand information on the various phases of science? It was the intent of the teacher to use such information as a departure from the usual procedure.

The teacher listed all the units usually taught in the sixth grade and under each she itemized the available sources of scientific knowledge in business and industry in the immediate area around the town. Next she listed the physical resources. She took stock of all the materials and equipment available in the school. She jotted down the names of persons who could serve as resource personnel. Finally, she surveyed her notes and felt ready for any possibility that the science interests of the children might offer. Could she lead them into the community for scientific knowledge? The usefulness of science in everyday life is so apparent when it is seen on every hand.

The teacher first introduced her plan by opening the discussion on what the pupils had liked in their previous study of science. The children talked freely and showed a wide range of experiences in science in

the lower grades. Next, the children were asked what they would like to study this year. These were listed on the board. Everything from atomic bombs to butterflies seemed to be there. It was soon discovered that some of these could be grouped under common headings, thus cutting down the number to be considered.

There were two sets of textbooks available and the pupils were given a copy of each. The teacher suggested that in order to have ready information, it would be well to confine choices to those found in at least one of the texts. The tables of contents were used for this, and if the interest were not found in a text, it was ruled out. There were still many potential units.

The teacher then posed the question, "Where can we get first-hand information about these proposed units?" After much discussion one boy came up with the answer: "If we cannot find information close by, we will not include the unit." After discarding three units, nine units still remained on the board. The pupils agreed to vote for the ones they liked best. They finished voting to find three units had only one vote each. It was soon agreed to drop these. The surviving units were found in the texts under the headings: "Health," "Seasons," "Transportation," "Communication," "Changes of the Earth," "Conservation."

A HURRICANE FURNISHED MOTIVATION

This preplanning occupied the science periods of the first week of school. On Monday of the second week the children were to decide which unit would be undertaken first. But school did not open on Monday! In fact, it was closed two days while a hurricane blew itself out.

What a sharing of experiences there was on Wednesday! There were accounts of the rush at home to lay in food, candles, kerosene for lamps, and batteries for flashlights and radios before the storm broke. No one could leave shelter after the storm started. One family plotted on a road map the path of the storm as reported by radio. Some had to leave flooded homes.

Pastures were flooded and cattle were stranded on little islands of high ground. One boy helped his father row a boat filled with feed for the cattle. He was disgusted, he said, for only last spring they had had to move the cattle from this same pasture because it was so dry the grass was gone. Dry pastures in April, wet pastures in September! This was the problem. Why did cattlemen have to face it year after year?

One girl had an answer. Her father had dug ditches on his ranch and used a pump to take off surplus water. He had planted his ranch with better grass. As a result, he had experienced little trouble during the storm. Would the class like to see her father's ranch?

FIELD TRIP

A field trip was now in order. After checking with the principal and the bus driver, the trip was planned for the next afternoon. Fortunately, the things which the teacher and pupils wanted to see could be reached on hard roads. An hour on the phone secured permission of the owners of land, ranches, and groves for the visits as planned. The county agent offered helpful suggestions and accepted an invitation to join the group.

Observations were made by the pupils and recorded in notebooks and on outline maps of the county. The route traveled and the location of each stop made were shown. Later these maps were redone in color to point up pertinent information. Some on-the-spot classifications and some obvious interpretations could be given, while other explanations had to be held for more information before any conclusion could be reached.

Back in the classroom, armed with notes and maps they had made, questions came thick and fast from the children. After lengthy discussions and much give-and-take, they summarized what they had seen:

1. Nearly level land unprotected by forest and grass floods easily.
2. Ditches and dikes save much land from floods.
3. Rolling land without cover is subject to sheet erosion.
4. Some types of soil hold water better than others.
5. Soil, forest, and water are related.
6. Water under control has many uses for man.
7. Many agencies help in planning soil, forest, and water conservation.
8. Work is under way for planned flood control and water conservation in the Kissimmee River Basin.
9. There are many scientific factors affecting such planning.

Museums are only one of many valuable community resources.

De Kalb County Schools, Lithonia, Georgia

BUILDING A YEAR'S PROGRAM

If science is to function in everyday life, its content must be presented in a tangible and concrete fashion. The *why* of a scientific fact is more important than the *what* of it. The chart accompanying this article shows how a sixth-grade teacher started with a current problem in the immediate environment and built the science program for the year. She reversed the usual order used by most classroom teachers. Instead of presenting the text in the beginning, she first caught the interest of the class by going into the community, then turned to the text and other instructional materials to verify the findings. The order of the procedure is as follows:

1. Observe	1. Field trips
2. Classify and interpret	2. Tentative conclusions
3. Verify	3. Experiments found in texts Still pictures Maps Resource persons Source materials Textbooks Library books and magazines

Such a range of activities in the study of science offers an opportunity for caring for individual differences within the class. Often a child with reading problems may have a great interest in science. He can find an outlet for his desire for success in performing experiments, caring for the bulletin boards, and helping in many other ways in forwarding plans of the class.

USING DOUBLE PERIODS

The class met for double periods on two days each week. One such double period was used for presentation of new ideas and concepts, clarifying scientific terms, and clearing other difficulties anticipated by the teacher, before the class turned to reading. Textbooks were used as source material. There was a three-grade range in reading levels in the books used, and any child could find a book he could read.

Another double period was used as a work period. Committees prepared reports, experiments, bulletin boards, and models. Reference books, maps, still pictures, films, and filmstrips pertinent to the current unit were placed in a bookcase used only for science. Another case housed the equipment for experiments. A long work table completed the science corner. On other days this time was used for field trips, to hear resource persons, or to show a film or filmstrip.

It was a full year, and it all started with a hurricane!

USING THE COMMUNITY AS A LABORATORY

Initial Problem: Wet and Dry Summer Pastures in Osceola County

Related problems	Field trips	Resource persons	Text No. 1	Text No. 2	Area in science
1. Why does Florida have a summer rainy season?	Local weather station	Local weather observer	"Weather and Climate"	"The Earth and the Seasons"	The earth as a part of the universe The earth and its changes
2. Why do some cities in Florida have water supply problems?	Local water plant	Chief engineer of plant	"Keeping Fit for Work and Play"	"Our Health"	Man and his environment
3. Can floods be controlled?	Tour of nearby areas to see results of flood and hurricane	County agent Rancher Grove owner	"Weather and Climate"	"Conservation"	
4. What measures are being taken to control floods in central Florida?	Trip to see large relief map of project	Chairman of basin project (local resident)	"Weather and Climate"	"Conservation"	
5. Why is the radio important during storm periods?	Radio station (Orlando) Local telephone office	Radio weather report announcer Telephone lineman	"Electricity and Its Use"	"Means of Communication"	Matter and energy are subject to change
6. Why are the Brahman cattle a popular breed in Florida?	Ranch to see prize show stock	Herdsman on ranch	"The Improvement of Plants and Animals"	"Changes on the Earth"	Conditions necessary to life
7. How are cattlemen improving their pastures?	Trip to see experiment in raising grasses	County agent	"Food for Growth and Energy"	"Our Health"	Living things and their activities

Laymen and Lay Organizations Will Help

By E. LAURENCE PALMER
Emeritus Professor of Nature and Science Education
Cornell University
Ithaca, New York

THE general education dictum that everyone should learn to understand the world in which he lives and become a member of the community of which he is a part may well be implemented by using community resources to enrich the elementary-school science program. Such a policy may serve a two-way function of bringing the community and the school into a cooperative effort that may be profitable to both.

A LETTER FROM THE POLICE CHIEF

The average community is blessed, or cursed, with groups of laymen whose hearts may be in the right place, but who do not know *how* to do what they *want* to do. Today I received a letter from the chief of police of a substantial New York community indicating that the sportsmen's club of which he is an officer wishes to do something to help his schools understand better the wildlife resources of the neighborhood, and offering services and money to that end. He seeks guidance on how to go about working with his own schools. He seems bashful about approaching his neighbors on a problem in which both are interested. No doubt the schools of the community are equally hesitant about seeking the cooperation of the sportsmen, the women's clubs, the garden clubs, the bird clubs, and even the scouting and juvenile club leaders. Such a situation can well lead to ineffectual work all around and even to misunderstandings.

SERVICES OF WILDLIFE FEDERATION

The National Wildlife Federation, of whose local unit our police chief is an officer, is in position of offering, without cost to the community, regional and local training to teachers; fellowships and scholarships to the graduates of the schools; consultative service thru correspondence; and movies, filmstrips, books, and pamphlets useful to teacher, student, and layman. For some of these services there is a nominal charge, as with the movies and filmstrips, but, for the most part, the assistance costs the community nothing.

In some cases the organization is in position to lend a hand in legislative programs designed to improve our appreciation of our natural resources, and to lend consultative service in connection with the de-

velopment of school curriculums, including the selection of supplementary literature useful in the classroom. The Federation's entire program is financed thru the sale of the well-known wildlife stamps.

UNINFORMED TEACHERS

At a recent meeting of elementary- and secondary-school science teachers, the relative merits of using museum materials and of making your own museum were discussed. One school made much of having encouraged one boy to make a collection of birds' eggs which was the envy of other schools. This was praised as a public service. Another school reported that the parents of some of the children had given the school a valuable collection of birds' eggs which had been found most useful in stimulating other children to make collections. The chairman of the group, a science teacher, registered no protest to the egg-collecting project which is entirely illegal and punishable by severe fines under state and federal laws. Obviously, she was totally uninformed on the legal status of wildlife, as were many other teachers in the group.

Closer association on the part of classroom teachers with such organizations as the National Wildlife Federation, the American Nature Association, the National Audubon Society, and the Izaak Walton League will not only help these service organizations attain worthwhile and unselfish goals, but will also help teachers serve the community in broader and more effective ways.

LEARNING FROM THE LAYMAN

One cannot justify educationally or otherwise much of the emphasis on purely academic accomplishment now representative of much elementary-school science. What good does it do one to be able to find out what direction north is if he does not know where he is or what is to be found to the north? And why go to the trouble of magnetizing a knitting needle to find north when the afternoon sun is beating in thru the schoolroom window or the moon is shining thru the bedroom window? The possession of new knowledge may not be so important as knowing what to do with the knowledge we have.

The practical gardener or the high-caliber sportsman may have much to offer the teacher that was never available in college courses. To the child or the adult, such experience may be functionally more important than some of that offered by the teacher-training institution. It takes all sorts of persons and all types of experience to make a world, and the wise teacher well trained in the orthodox fundamentals of his profession should be able to learn much from the practical man-about-town.

SELECTING MATERIALS

Take the average elementary-school science text or outline. Look it over to see the degree to which its content deals with the problems of the here and now of the pupils involved. Suppose, for instance, one book makes a classification of animals on the basis of their food habits and lists hawks and herons as plant eaters. If the classification is open to question, consult the members of a local bird club before the book is adopted or, better yet, refer it to the local club for a practical evaluation of its merit. Better still, watch some hawk or heron feeding.

If the book or outline under consideration as a guide for elementary-school science is to be used in a city, it should contain an appropriate number of problems that are urban in nature such as those that concern dealers in perishable produce and manufacturers who must process raw materials.

Natural juvenile interests like fishing, hunting, trapping, swimming, eating wild fruits, and camping should never be overlooked. Every principle in science advocated for understanding by elementary-school leaders may find expression in what pupils do or want to do. Which is more important to a youngster: that he understand the anatomy of an earthworm or that he know how to raise earthworms either for sale to his dad or for use himself?

ENLISTING HELP

Teachers of science should get some of the free and inexpensive literature available from the National Wildlife Federation in Washington, the Audubon Society in New York, or the Izaak Walton League in Chicago. The children will be greatly interested in much of this material.

Teachers also should enlist the cooperation of some local layman or lay group who may be greatly flattered to be asked to help in the school program. Many teachers will be surprised at the new interest in school displayed by some youngsters and at the willingness of most laymen to help where they can.

Why should a chief of police ask an outsider how he could contact and work with the schools? Both he and the schools should have recognized years ago that their cooperative efforts would be mutually profitable.

Outdoor Science Education

By RICHARD GERRY DURNIN
Director, Antioch School
Antioch College
Yellow Springs, Ohio

IN RELATING some outdoor science experiences that we at the Antioch Laboratory School have had, it is realized that our resources in this area are exceptionally fine. The Glen Helen Reservation—960 acres for community recreation, for study of constructive land use, and for enjoyment of natural beauty—is administered by Antioch College and lies only a short distance from our elementary school.

Outdoor science education and trends in these programs are receiving increased attention in the professional journals that are concerned with elementary and secondary education. More and more schools and individual teachers are striving to get boys and girls out of the classroom for part of their science work. It is not easy to schedule field experiences for children in large city schools, but it is not impossible.

Many school systems thruout the country own land areas having great potential value for science education. In telling about our experiences, it is hoped that those schools that have available areas will work toward their utilization in an outdoor science program, and that others will explore possibilities for planning ahead.

RESOURCES OF THE GLEN HELEN RESERVATION

The Glen Helen Reservation provides us with a great variety of land forms and uses. Within the acreage children can see how the Yellow Springs Creek has cut thru limestone forming the Glen, a school forest of Christmas trees maintained by the village children, cascades cutting thru steep wooded valleys, a site of the Mound Builders who lived 300 years before Columbus, the remains of a stage road that once connected Cincinnati with Cleveland, acres of productive land including pastures and cropland, stone and gravel pits, springs, streams and swamps, a bird sanctuary, 30 species of mammals, outcroppings of rock (dolomite, shale, and limestone), fossils of the Silurian period of 350 million years ago, the debris of the moraine left by the last visit of the glacier approximately 25,000 years ago, and an amazing pattern of plant life. Boys and girls are able to see the living story of southwestern Ohio.

Public Schools, Baltimore, Maryland→

STUDYING INDIVIDUAL PLOTS OF LAND

Glen walks have been common and popular among school children in this vicinity for some years. It was felt, however, that our children in the intermediate grades would like to make a more detailed study of some phase of this tract. The fourth-, fifth-, and sixth-graders selected plots of land about 24 feet square in a section of the Glen given to us for school use. These plots were adjacent to one another, and the area was selected because of the variety of land forms present in a relatively small region.

The area selected was hilly and included a creek. Here were animal holes, various young and mature trees, squirrel nests, mosses, interesting plants, toppled and decaying trees, exposed bedrock, overhanging cliffs, and the creek with its water life.

The children first explored the plot area and measured off their sections. Stakes donated by the Glen office and hammers borrowed from our industrial arts shop were taken on our first trip. Next we made rough maps of plots in the area. Here the boys and girls found a need for more instruction in map making. Map legends were designed to indicate large rocks, streams, swamps, hilly areas, low areas, large trees, pathways, and other features found within the plots. The maps were simple and often crude, but they helped the children observe more closely the features of their individual study plots.

Our visits began in late winter, but it is felt that early fall, at the beginning of the school year, is the most desirable time. Observing the seasonal change with concentration on one piece of land was one of the purposes of this activity. On subsequent class visits reports were made on the signs of seasonal change. Great interest was shown by the youngsters, and many made visits on their own time, reporting changes and other observations.

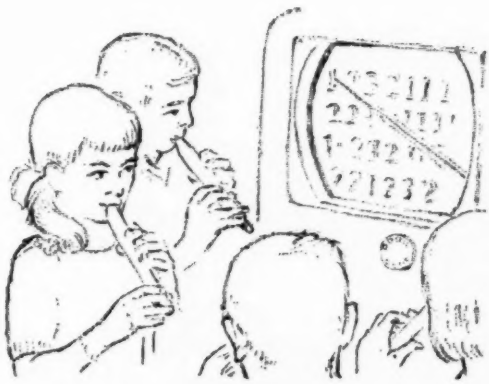
No attempt was made to identify a large number of plants and animals. Such was not the purpose of our work. We were anxious to have children closely observe land use, seasonal changes, the interdependence of animals and plants, and conservation. Later visits introduced the study of one phase of life on the plot, for example, insect life.

The program should be expanded to include more school children, with each group doing what is possible at various age and experience levels. There was great meaning in the whole program for the children. The boys and girls felt that the land was theirs. The purpose of science education being to change behavior, children became more conservation minded. They saw what happens, scientifically and esthetically, when wild plants are indiscriminately pulled up, when mosses are torn off rocks, when trees are marked with knives, and when streams are polluted.

CHAPTER SEVEN

Using Radio and Television

MANY worthwhile science demonstrations that are difficult and sometimes impossible to set up and carry out within the limited confines of the classroom can be brought into elementary schools by radio and television. Here is an opportunity to use with great effect the knowledge and skill of the master teacher, a chance to teach certain lessons that may require more equipment, facilities, and science "know how" than the typical classroom teacher possesses. There are limitless possibilities in programs transmitted into children's homes during out-of-school hours, the value of which is already being demonstrated by a few commercially sponsored as well as school sponsored programs. Lessons by radio and TV can also enrich the science experiences of homebound crippled and sick children. These mediums offer excellent opportunities for citizens to see schools in action.



Teaching Science by Television

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ABOUT a year and a half ago the public schools of Washington, D. C., began experimenting with television as a medium for teaching science to the children of the elementary schools. The air time and studio facilities were donated by WNBW-NBC. Twenty-five classes began the experiment. Altho only three school buildings were equipped with TV receivers, the interest of participants was high. Arrangements were made for some of the classes to visit homes of children in order to follow the programs, while some PTA's rented receivers for their schools. Long walks to the homes, inclement weather, and even missing the recess periods were forgotten as the programs progressed.

Before six weeks of the experiment had passed, 80 classes were following the TV work, and PTA's were buying receivers for their schools. Classes in the neighboring areas of Maryland and Virginia were asking for guidance materials and were following the telecasts. Today 86 school buildings in Washington have at least one TV receiver; 10 have two or more. Science via television is made available to 183 classes, comprising 6254 children in the District of Columbia school system.

Two series of science programs are presented in alternate weeks. As the subjectmatter of the two series is different, the classroom teacher is able to select the programs that are appropriate for the work, plans, interests, and abilities of the class. A lapse of two weeks between telecasts gives a teacher time to implement the work of the telecast.

NOT TO REPLACE BUT TO ENRICH

The TV programs do not take the place of work done by classroom teachers or special science teachers. They are planned to enrich the science programs of the classes, to stimulate interest, to present ideas for leisure-time activities, and to present materials that otherwise could not be used.

The subjectmatter presented is well within the framework of the curriculum. The science problems are ones with which teachers most often request help, ones that are pertinent to seasonal activities or current happenings, or hold great interest for the children. In planning a series, balance is maintained between the various fields of science so that a well-rounded program can be presented. The activities are

planned carefully so that each television program, as well as the series, presents a variety of ways of working, and of materials with which to work.

No entire area is fully explored. This would deprive the teacher of developing new phases of the work. Several telecasts may deal with one area of study, but only one problem is studied in a single telecast. The problems are studied in such a way that the application of the learning is not limited to a particular situation. For example, the work in the fields of air and water was applied by different teachers to studies of weather, aviation, transportation, the community, and the home.

METHODS OF PRESENTATION

In presenting the programs, no studio class is used. The teaching is straight to the viewing audience. Because of this method of presentation the participants feel that the TV teacher is their teacher; that the teaching is especially for them; that they are free to talk to the teacher, answer and ask questions, as well as work actively with the teacher. Children like to participate, not merely sit by and look on while other children are having all of the fun.

Great effort has been made to keep the telecasts out of the category of "shows." Having one teacher do all the teaching in a series and not using a studio class but teaching straight to the viewing audience have been great factors in creating the feeling of a TV classroom. Interest on the part of children and teachers, and the participation and activities of the viewers, prove that all consider the work as interesting schoolwork and not shows.

GETTING READY FOR TELECASTS

An outline of the proposed series of science telecasts is sent to the schools at the beginning of the term. This presents the subjects of the telecasts, a short description of each program, and the dates. It is understood that happenings of interest that will fit into the series will be presented when conditions make it desirable.

SERIES ONE—SCIENCE TV PROGRAMS

February 3, 1953
Is Air Real?

Proof that air is real and has certain characteristics.

February 17, 1953
Air Works for Us

A study of the "push" of air and air pressure and how we make it work for us.

March 3, 1953
Fun with Water
Experiments with water as we use it every day and some of its characteristics.

March 17, 1953
More Fun with Water
More experiments with water to develop better understandings of the way water works for us.

March 31, 1953
Let's Dye Easter Eggs
Learning from the study of air and water will be applied to the dyeing of Easter eggs.

April 21, 1953
Forecast: Rain and Cloudy
What makes it rain? Where does the rain come from?

May 5, 1953
Our Land Is Changing
Demonstrations to show how rain is changing the land of our neighborhood.

May 19, 1953
The Birds Are Back
Birds that live around us, where to look for them, and some of their habits.

June 2, 1953
Along a Stream
Life along and in a stream.

June 19, 1953
The Zoo in Our Back Yard
Homes and activities of some of the animals that live in our neighborhood.

A week before each telecast, a teachers' guide is sent to the schools. This gives the teacher suggestions for getting the class ready for the program, an outline of the concepts that will be developed, suggestions for furthering the work thru various types of activities, and lists of references and materials that the teacher and children may want to use.

STAGING PROGRAMS

The programs are staged in a direct manner, using a natural conversational method of presentation. Narration, interrogation, illustrations, and demonstrations are used thruout the series. The narrative parts are concise and the lecture technic is avoided. The methods used in the audio parts of the programs provide short pauses, giving opportunities for children's responses, focusing attention on particular materials, or accenting certain activities.

It is recognized that the interests of children in television classes are not captive. The science TV programs must command attention, not

just expect it. Therefore, the separate programs, as well as the entire series of programs, are planned and developed so that they will be alive from beginning to end. If they are stilted or dull, they will not hold the children's attention. Furthermore, the programs must be fun; the audience and the TV teacher must enjoy them.

BREAKING DOWN BARRIERS

Questioning, asking for suggestions, playing games as a means of summarizing or reviewing, and laughing with the children when something amusing happens are ways of breaking down barriers between the studio and the classroom. The programs are presented and taught just as they would be in the individual classrooms. Questions are asked and the work so paced that the children have time to respond. Parts of some programs are done directly with the children, having them work with the TV teacher. Questions during the presentation bring the teacher and children nearer to each other. "What do you think will happen?" "Should we try that again?" "Is this what you want to know?" These are bridges between the studio and the classroom. They create a feeling of realness and of personal contact.

Certain phases of some experiments are planned so that something will not work the way it is expected to work. Asking, "What do you think is the matter?" or "What would you suggest doing?" brings the children directly into the activity of the telecast. Schools or particular pupils are often spoken to individually and suggestions made for further work in order to make the pupils realize how closely they are related to the teacher.

LEARNING NEW TERMS

New words or terms are used naturally where the context makes the meaning evident. From the moment of presentation of the new terminology and during the development of its meaning, it is superimposed on the screen. The meaning is emphasized by stressing what is happening or being viewed as the word or words are used. Labels and cards are used for the names of some materials. Diagrams, charts, cartoons, and pictures are superimposed on the screen for the development of terminology and meanings.

SUMMARIZING THINGS LEARNED

Learning is summarized quickly near the end of the program by asking "What have we done so far?" "What have we found out?" "Have we answered our question?" Time is given for the children to respond. Often the children are asked to summarize with the teacher, pronounce the words, or participate in some other way.

Public Schools, Baltimore, Maryland. A WAAM Photograph.

Aviation has always been a popular topic with Baltimore school children.

At the end of the teaching period, it is necessary to focus not only on the new learnings but on creating interest and a desire to go on with the work. At the end of each program something is presented that will leave the children with an interesting problem, something else to find out, or ideas for something to make or do. The action of some spectacular apparatus or toy, definitely related to the telecast but not used before, may be shown to stimulate curiosity and the desire to learn more.

The visual or video parts of the programs are of paramount importance. They are developed so that they will move slowly enough for the children to see, follow, and remember. They must be clear, simple, and definitely planned.

USING MATERIALS

The materials used in the science telecasts are the type that children can get or make. Improvised and homemade materials are stressed. Before any materials are used on a TV program, they are carefully analyzed to make sure that they fit into the general plan, that they contribute to the solving of the problem and to the formation of the basic understandings being developed. The materials also must be clear and simple. They must be easy to handle and manipulate, thus preventing confusion for teacher and children. And, equally important, the materials must provide motion. Motion is essential. If a static

material has to be used, it is combined with materials that have motion. The television camera itself is used to add motion to visual aids. Panning, tilting, fades, superimpositions, and other technics add motion and action to what might otherwise be static material.

GETTING VARIETY INTO PROGRAMS

If all programs follow the same pattern, they become monotonous and the children lose interest. Each telecast must have its own individuality, its own particular form of presentation and procedure, depending upon its subjectmatter, demonstrations, and illustrative materials. Variety arouses the interest of the children and gives them other angles of the work in progress. Many kinds of apparatus, homemade materials, charts, diagrams, cartoons, slides, films, movies, toys, and models, as well as live materials, are used. The participation of people who have a particular appeal for children and who are outstanding in the work being studied also provides variety.

Television is an important medium for teaching science directly to the children; it is an important medium for stimulating interest in science and thus getting more science teaching under way in the classrooms. When the children's interests are aroused and stimulated, they are ready and anxious to go on from where the program stops. This interest results in pressure for more science work.

HELPING HOMEBOUND CHILDREN

Learning science by television is a great help to children who must be absent from school. Those absent for a short period of time, as well as those who must have home instruction over long periods of time, follow the telecasts, carry on the activities, and progress with the work. The home instruction visiting corps keeps in close touch with TV work, sees that the homebound pupils have the necessary materials, and carries on the work with the children just as classroom teachers do.

USING COMMUNITY RESOURCES

Television offers unlimited possibilities in presenting and using community resources. By its use, it is possible to present and use many more materials and a greater variety of materials than could be taken to the schools. It also makes it possible to present to many children materials that otherwise only a few could see or profit from. Compasses borrowed from the Civil Aeronautics Authority were studied by the entire TV class. It would be impossible to borrow these materials for all classes. It would be equally impossible to transport them to all schools.

Valuable resource people can be brought into many classrooms by TV.

Parachute riggers from the Naval Air Training Unit at Anacostia Naval Air Base made it possible for thousands of children to get a close view of a parachute and its complete operation. A Navy pilot demonstrated to the TV classroom just what he does to prepare his plane for flight and take it off the ground. The children, following all of his actions as if they were going to take off too, felt they were really getting flight instructions. A meteorologist from the Weather Bureau gave the children understanding of the formation of clouds and rain by his chalk talk, films, and "real" weather instruments.

PUBLIC RELATIONS

Using the medium of TV for teaching science is an excellent way of acquainting parents and the community in general with the science program. It is surprising how many adults who have no contacts with the schools follow the telecasts. This has produced interesting and helpful results. Offers of assistance in collecting and lending materials and in talking to classes have come from people who have become interested. Adults have taken the time and trouble to write in, telling what they have learned and their experiences in carrying on some of the activities. One person wrote, "All in all, I feel I was born a decade too soon. Wouldn't it be fun to go to school like this?"

Parents have reported the interests and activities of their preschool children. Studying science with their science teacher is a "must" for these youngsters. They "collect materials," "work with their TV teacher," "are more alert to the happenings around them," "ask their families even more questions," and "are enlarging their vocabularies in a noticeable way."

PRINCIPLES

After a year and a half of continuous experimentation with teaching science to elementary-school children by television, it is felt that:

1. Science can be taught effectively to children of the elementary school via television
2. Science is a natural for the medium of television
3. Television has potentialities for the teaching of science not inherent in any other medium
4. The direct method of presentation has more meaning and appeal for the children of the elementary school than the use of a studio class
5. The method of presentation which provides many opportunities for active participation should be used
6. The presentation should not be a lecture or show
7. Each program and all of its phases must follow one central theme
8. Effective and attractive science television programs can be produced only thru careful selection of subjectmatter, visuals, and methods of presentation, and only after thoro preplanning and rehearsing.

Implementing Classroom Instruction thru Radio

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EDUCATIONAL broadcasting by radio is still in its infancy, even tho school systems thruout the United States have experimented with it off and on for years. There is, however, enough good experience with it to show that it has great potentialities. It seems quite certain that television also will soon be in the classrooms and will offer tremendous possibilities for bringing much of the world to the eyes and ears of the pupils. All who are interested in educational progress are obligated to investigate these new mediums so that they may be made to contribute as much as possible to child growth and development.

PROGRAMS CAN BE EFFECTIVE

Radio programs have become an important part of the elementary-school science offerings in many cities and in some states. In some instances, the programs are written and produced by members of the instructional staff of a local school system, and are broadcast over a school-owned station or over a local commercial station. Such programs can be made to serve the particular needs of the school system. Perhaps a new course of study needs to be interpreted, or possibly it seems desirable to stress the experimental approach to science. It seems to be established that if the programs are well conceived and attractively produced, they will have a great influence on classroom practice. An important idea or technic may reach hundreds of classrooms simultaneously by means of radio, in contrast with the weeks of travel from school to school which otherwise might be required of some supervisor or consultant.

TYPES OF PROGRAMS

Many different types of programs have been tried and found effective. Straight narration of scientific information can be good if the information is inherently interesting and if the narrator is really gifted as a storyteller. A script may be written to dramatize a scientific event or to present important aspects of the work of some famous scientist. A popular type of program is in the form of a conversation between a scientist and one or more boys and girls of the ages of those in the

audience. Interviews with scientists or with public officials who are responsible for work which is scientific in nature have been widely used. The type of program which requires actual participation by the classroom audience has been found particularly appealing and effective. A detailed description of a program of this character is given later.

RADIO PROGRAM HANDBOOK

If radio programs are to be used effectively by the classroom teacher, a handbook describing the programs should be in the hands of the teacher well in advance of the broadcast. This gives time for adequate classroom preparation. The programs may then become an integral part of a planned sequence of activities, rather than just an interruption in the daily schedule. Furthermore, the classroom teacher will then have the opportunity to use those programs which show promise of being useful in his particular class and to reject those that seem to offer too little to justify the time and trouble.

THE SCIENCE SERIES IN ST. LOUIS

As a specific illustration of the way in which a school system may use radio in elementary science classrooms, a type of program which has proved quite useful in the St. Louis public schools might be considered. Several times each week Radio Station KSLH, owned and operated by the St. Louis public schools, presents a series of science programs that are delightful to children in elementary-school classrooms. These programs are planned by the Elementary-School Science Radio Committee, whose membership includes classroom teachers, elementary-school principals, and the science consultant for the St. Louis schools. This committee seeks to bring into classrooms, by radio, programs which will interest children and which will help the teacher in using the St. Louis course of study in science.

One of the first questions which will be raised in this method of science teaching is: "How can one present a good science lesson without laboratory apparatus to demonstrate natural phenomena?" In the radio programs this problem is solved very simply. Each semester the staff of Station KSLH supplies the classroom teachers with the necessary handbooks for each program series.

TYPICAL PROGRAM

Let's examine a typical program from the third- and fourth-grade series, "Science Around Us." In this series, the pupils carry out the instructions of the narrator as they are heard. The program under consideration is entitled, "Let's Make a Compass."

The basic concepts pointed out in the handbook are: "A compass is a magnet suspended so it will swing freely. A compass points approximately north and south." Such concepts are basic in the understanding of simple magnetism and in the understanding of how a compass functions.

A reference in Craig's *Science for the Elementary School Teacher* [1] is given so that no matter how little academic preparation the teacher has had in the field of science, he is able to get all the necessary information before the broadcast.

Equipment

The equipment listed in the handbook is simple and can be obtained from the science room in the school or from certain enterprising pupils in the class who can always be relied upon to bring materials from home. The following items will be needed:

1. Magnetic compass
2. Magnet
3. Iron nail
4. Darning needle
5. Two small corks
6. Shallow glass or porcelain bowl filled with water (Do not use iron or enamelware pans.)
7. Ruler
8. Pins or wire brads
9. A large map of North America showing the north magnetic pole.

Getting the Class Ready

Before the broadcast the materials are assembled in sets, and the class is divided into groups according to the number of sets of materials available. In each group two children, a boy and a girl, are selected to carry out the instructions during the program. These two assistants in each group will be designated "Mr. North" and "Miss South" for this particular experiment.

As the scheduled time for the program approaches, the teacher groups his class around the apparatus and turns on the radio. Classes in many St. Louis schools then follow the instructions of a master science teacher and conduct the experiments described.

Listening In

A class period in which the radio program is used may go as follows:

Miss South, will you place the needle of the compass on the holder so that it points east and west? Now watch it swing back and forth, back and

[1] Craig, Gerald S. *Science for the Elementary-School Teacher.* Boston: Ginn and Co., 1940. 551 p.

forth, until it finally comes to rest with the painted end pointing almost due north.

Mr. North, will you go to the map and point out the position of the magnetic pole in northern Canada for the class while we are waiting for the compass to come to rest? That is the spot toward which all magnetic compasses in the northern hemisphere point, and that it why we call that end of the compass the north pole.

Now Mr. North, stroke the darning needle with the end of the magnet marked "S," moving from the center to the end of the needle. Do this quickly about 10 times. Hold this end of the darning needle near the end of the compass that points north. Notice how the compass moves away from the darning needle.

By stroking the darning needle with the end of the bar magnet marked "S," you have rearranged minute particles called molecules so as to make a *north pole* of that end of the needle. When the *north pole* of the darning needle approaches the north pole of the compass, the two repel or push each other away.

Observe carefully what takes place because it will be very important in our discussion of the electric motor later on.

NEW VISTAS FOR THE CHILDREN

Thus a master teacher in the radio station takes the class thru the explanation of the compass and how it works. This is not the usual lecture method wherein it is difficult to hold the attention of young children. The boys and girls actually participate in these experiments.

The broadcast takes 15 minutes of class time, but it opens up new vistas for the children and gives the classroom teacher valuable aid in the performance of experiments in a realm that may be outside his experience.

Science is today on a plane of high significance and importance. It is no longer, if indeed it ever was, a mysterious and occult hocus pocus to be known only to a select few. It touches, influences, and molds the life of every living thing. Science teachers have a great opportunity and responsibility to make a large contribution to the welfare and advancement of humanity. The intellectual aspects of this responsibility are at least co-equal in importance with the material. Science is a great social force as well as a method of investigation. The understanding and acceptance of these facts and this point of view and their implementation in practice will, more than anything else, make science teaching what it can and should be.

—*Science Education in American Schools*, Forty-Sixth Yearbook, Part I, National Society for the Study of Education.

Televising Science in Baltimore

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YOUNG Baltimore takes readily to science on TV. One-half of the Baltimore public-school children sampled by questionnaire picked *science* as their favorite subject for television lessons. They were not alone in this choice, for a majority of parents and teachers as well indicated in the same questionnaire that science was one of the most effectively televised subjects in the elementary-school curriculum.

REGULAR AND EMERGENCY LESSONS

The information quoted above was taken from questionnaires sent out to children, teachers, and parents, as a follow-up of the emergency lessons televised to Baltimore school children, when their schools were closed for four days in January 1953 because of a strike of city employees. With only 72 hours to make their plans, the members of the steering committee of supervisors who outlined the emergency lessons made a point of including science in the lessons that were to be televised for the benefit of children at home. This was not a shot in the dark, for previous experiments in this area of televised science lessons had been successful with Baltimore classes, and the committee felt that science lessons should prove valuable and acceptable to boys and girls viewing the programs at home.

There was one marked difference, however, between programs which had been televised for classes in the past and those which were sent into the homes of strike-bound pupils. Previous lessons had been beamed to classes *during school time*. Materials had been sent ahead of time to each teacher whose class was using the lessons, materials which included suggestions for pre-telecast and post-telecast activities.

The emergency programs, however, had to stand alone. There was no classroom teacher to orient children. Tommie and Joanie turned the dial, adjusted the picture, and there it was, *school on the screen*. Any follow-up was entirely of the child's own volition. Here, then, was a challenge. Would the televised science lessons (and the other kinds of programs as well, of course) be effective when viewed by children who were watching at home, probably surrounded by distractions, and in many cases without any adult supervision? Would children be motivated

to carry thru some worthwhile activities at the close of the TV lesson? Reports on the questionnaire indicated the following:

Question: "What did you do after the show?"
8,016—Talked it over with young people who were watching or listening to it with me.
8,539—Talked it over with my teacher in school.
6,297—Did the assignment given by the radio and TV teacher.
4,100—Read something.
4,430—Tried out or made something demonstrated or explained during the show.
10,820—Tuned to the same show next day.
9,772—Did nothing related to the shows.

Altho these figures refer to all the emergency programs, they still have significance for science teaching on TV, since the science lessons were voted the most popular of the lot.

Interesting anecdotes about the science lessons drifted back to us. Some school buildings remained open during the strike, and children in many of these took advantage of the TV lessons. One class became fascinated by the science series dealing with thermometers, and when the cessation of the strike canceled the emergency TV lessons, these children invited the TV teacher to come to their classroom to finish the series.

REACTIONS OF OLDER AND YOUNGER CHILDREN

Another story that came to us frequently during the emergency was that many elementary-school children, when they had finished seeing their own programs on WBAL-TV, dialed Station WAAM, where secondary lessons were in progress, to see the junior-senior high-school series on aviation. There was evidence that elementary-school children enjoyed these lessons and were able to get something from them.

Altho the science lessons were rated high by teachers, children, and parents alike, there was one flaw in their organization which should be pointed out. The science lessons were all labeled "elementary," and started out with a lesson on thermometers, on a primary-grade level, using primary-grade children. The lessons progressed in difficulty and older children were then used on the program, but some potential viewers were lost to us, because older children tuned in the first lesson, saw small children, labeled the lesson as "baby stuff," and tuned out. A more specific labeling of lessons as "primary" or "intermediate" would have been desirable.

The questionnaire showed that while younger children will watch educational programs planned for and featuring older boys and girls,

University Elementary School, Laramie, Wyoming; photo by Paul Holtz→

these same older children tend to scoff at shows which involve younger pupils. There was no evidence that any junior high-school student watched the elementary-school thermometer lessons, but elementary-school children viewed and enjoyed the secondary-school series on aviation.

A SERIES ON AIRPLANES

Aviation has always been a popular and successful topic with Baltimore school children. A series on airplanes for sixth grade was planned and presented during 1952 as part of our regular programs for in-school viewing, with the following organization:

Lesson 1—What Is Air?
Lesson 2—Air Pressure
Lesson 3—Bernoulli's Principle
Lesson 4—Bernoulli's Principle
Lesson 5—Application of Bernoulli's Principle to the Wing
Lesson 6—How Is an Airplane Balanced?
Lesson 7—Parts of an Airplane
Lesson 8—How We Operate an Airplane
Lesson 9—How We Operate an Airplane
Lesson 10—The Future of Aviation

Information for teachers was sent out ahead so that the classroom teacher knew in advance how much ground the TV teacher would try to cover and what materials her own class should have on hand in order to work along with the TV instructor. A great deal of equipment for this series was lent to us by the science department of Maryland State Teachers College.

STUDYING DOGS

One of our most successful programs has just drawn to a close, a program combining elements of science and social studies, centered around a sure-fire attention getter, *dogs*. Called "Best Friend," the program was organized around the classification of pure-bred dogs into the six groups: working dogs, sporting dogs, terriers, toys, hounds, and nonsporting dogs.

Animals of each breed were presented with a study of how each dog is peculiarly suited to a certain job he is expected to do. For instance, one program pointed out the Chesapeake Bay retriever's coat with its water-shedding property and its ability to keep out the cold from the icy waters during duck hunting season; the set of the Chesapeake's ears to keep out water; and his prodigious strength and swimming ability, as examples of marvelous adaptations to environment and a specific job.

The Afghan hound's strange hip conformation that enables him to leap over high rock barriers in his mountainous home; the German

shepherd's smooth, free-flowing gait which was of inestimable value in his original job of sheepherding over a far-flung terrain; and the combining of the individualized and different characteristics of fox terrier and fox hound in the hunting of foxes in Britain were stressed.

The proper care, feeding, exercise, and grooming of each kind of dog worked in quite well with a unit on pets in our science course of study, and the history of each breed with maps and pictures added to the general value of the program.

The Maryland Kennel Club was an interested and most helpful ally in producing the program, and its secretary furnished us with outstanding specimens of each breed.

The response to this program has been heartening, with children of all ages, from Grades II thru VI, watching, learning, and liking our "Best Friends." Mail response indicated a good audience among the general public also, with requests ranging from "Where can I enrol my dog for obedience training?" and "How can I make my collie's ears tip over?" to queries from two farmers, one in Maryland and one in Pennsylvania, who saw in our little Shetland sheep dog a fine fellow for general farm work.

ADVANTAGES OF TV TEACHING

The program on dogs and the one on airplanes illustrate very clearly some of the main advantages of science teaching on TV. Both programs made available to many children at one time the services of people highly skilled in a particular field, people and skills not readily available to every classroom teacher.

Materials and equipment used on the programs were also special and unusual, becoming even more important when viewed close-up by the TV camera. The close-up shot is a powerful force in science teaching, enabling children to see an experiment more clearly than they could in the actual classroom. The close-up shot can make available to many children scientific demonstrations that would ordinarily be available for close study to only a few at a time.

Educational TV is valuable also as an inservice training device for teachers. Many classroom teachers report that they gain new ideas for their own teaching when they watch skilled teachers on TV.

GUIDEPOSTS

In planning science lessons for TV, several guideposts should be kept in mind:

1. Involve the TV audience in the activities going on in the studio. When the children watching the screen either at home or in the classroom are

working along with the TV teacher, they feel that they are a part of the lesson.

2. Repeat the experiments. Repetition is valuable educationally and is a boon to the cameraman.

3. Limit the number of concepts you plan to develop in a single lesson. It is better to use many experiments to prove one fact than to try to cover a great deal of ground. We found that two programs were necessary for the development of the idea of Bernoulli's Principle.

4. Try out all experiments before the program.

5. Try to cue the TV director and cameraman as to your movements.

6. Check all visual materials you would like to use with your TV director. Some may not be suitable for TV, such as prints with a high gloss.

7. In planning your science program, use the resources of the community: the local conservation organization, ornithological societies, sanitation engineers, university scientists.

8. Select a good classroom teacher and give him an opportunity to teach many lessons on TV so that he will learn the special technics of TV teaching. This is a better procedure than to throw in a new teacher each week.

SPLIT-SCREEN TECHNIC

A few years ago the Baltimore public schools and Station WBAL-TV conducted an experiment that was in itself an interesting scientific experience. For the first time, it is believed, the technic of "horizontal wipe" (split screen) and the use of a mobile unit made it possible for a teacher in the studio to see and to talk with pupils in a school five miles away who were watching a science lesson on volcanoes.

The materials used in the lesson were interesting. A model volcano filled with ammonium bichromate erupted in a most realistic and dramatic manner, spewing up "lava," building up its cone, and sending streams of "lava" down its sloping sides. Other visual aids were used: a cut-away section of a volcano, a piece of real lava, charts, and pictures.

But the technics used by the engineers were as scientifically interesting as the lesson itself, for the split screen made it possible for the teacher and the child who was questioning her to appear on the screen at the same time, while the presence and smooth functioning of the station's mobile unit outside the classroom window provided a two-way "audio" for give-and-take between teacher and class.

VALUES FOR CHILDREN

It would seem that science taught by television would have many values for children: opening up new areas of interest, orienting children to a broader environment, relating science more closely to everyday experiences, assisting in improving classroom instruction, and providing new ideas for teachers.

Science on the Air

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Morningside and Crystal Spring Schools
Roanoke, Virginia

THE following is a portion of a script from a radio broadcast made by pupils of fifth- and sixth-grade classes over Station WDBJ (Roanoke, Virginia) during the 1951-52 school term. The children tell about some of their experiences in science during the school year.

Billy: This year we have been studying moths, butterflies, and other insects. We caught them and brought them to class. You should have seen the jars, boxes, and tin cans we brought from home. In them we watched how they fed, how they grew, how they lived, and how they kept their homes. We had lots of fun collecting specimens. Sometimes we found them while we were playing baseball after school on warm afternoons in October, or when gathering vegetables in the garden, or just any place outdoors.

Loretta: When we caught butterflies and brought them to school, Miss Forbes showed us how to kill them in a glass jar with a wad of cotton wet with Carbona. Then we stretched the wings on a board with pins. We let them stay like that for several days, and afterwards we mounted them in open cardboard boxes covered with cellophane. The best ones we placed in the case in the hall for everyone to see. We learned their names and labeled them so everyone could tell what kinds of butterflies they were.

Howard: Oh yes! Collecting butterflies is one of my hobbies now. My father helps me, too. Together we collected 19 different kinds of butterflies and moths last fall. We mounted them all. You should see them!

Joyce: One morning Loretta was helping her mother gather carrots in the garden. She found some worms with green and yellow markings on the carrot leaves. Of course, she brought them to school. Loretta, tell what Miss Forbes helped you do with these worms.

Loretta: Well, Miss Forbes gave me an old aquarium with some peat moss in the bottom. I put the worms in the aquarium and also a jar of water to hold some fresh carrot leaves for them. Then I covered the aquarium with some cheesecloth so the worms could not crawl outside. They are very greedy worms, so we had to feed them fresh carrot leaves every day.

Joyce: Tell how you found that these worms could protect themselves from birds.

Loretta: One day while I was feeding them I noticed a spicy odor. After a while I found that this odor came from the bright orange horns on the worms. We read in one of our books that the worms give off this odor to keep birds from eating them.

Joyce: Tell what happened to these worms.

Loretta: The worms shed their coats several times for about two weeks. They grew all that time, too. Then at the end of two weeks they stopped eating and clung to the side of the aquarium. Here they made a hard brown case around themselves. Miss Forbes told us that this case is a chrysalis and that they will stay in this all winter.

Joyce: You remember that our reference books told us that the worms will come out as beautiful black swallow-tail butterflies next spring.

Loretta: Yes, we look at them often and we sprinkle them with water so they won't get too dry. We can't wait to see them come out.

Joyce: Gary can tell you about another butterfly we saw go thru its life cycle.

Gary: I watched the monarch butterfly from the egg to the adult stage in the same aquarium that Loretta used for her carrot worms.

Joyce: Where did you get your worms?

Gary: Henry brought some milkweed leaves that had tiny round green eggs on them. In a few days small caterpillars with yellow, black, and green stripes hatched from these eggs. Then the caterpillars ate the milkweed leaves.

Joyce: What do you call this stage of change?

Gary: We learned that this is the larva stage. These larvae grew and shed their skins many times until they were about 2 inches long. Then each caterpillar hung head down from a leaf.

Joyce: We could hardly believe our eyes. Right before us they changed into soft green bags. On these green bags were dots of gold and thin black bands.

Gary: Were we surprised to see these pretty green bags harden! We decided to write down all the changes we saw, so we kept a diary for one, and each day we wrote down how it looked.

Joyce: Wasn't it just 13 days before it came out?

Gary: Yes. At the end of 13 days we all saw the most beautiful butterfly come out, all orange and black. The bag it left behind looked like cellophane.

Joyce: Do tell what we did with this one and why!

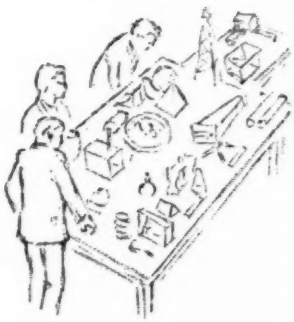
Gary: This one we let fly away to go south like the birds. We read in our reference book that this is the only butterfly that flies south.

The children continued telling about watching a praying mantis, crickets, grasshoppers, and spiders. They also related how many famous composers had used the songs of different insects in their music.

This broadcast was a report on actual classroom experiences, arranged by the children and the teachers. These activities in science were started as soon as school opened in September and were carried on during the fall and winter months. The broadcast, which took place in January, served as a culminating activity for the children's work in this phase of science.

CHAPTER EIGHT

Improving Science Teaching



TEACHERS of elementary-school children sometimes lack confidence in their ability to teach science. Part of this lack of confidence can be attributed to the fact that they either had little or no training in science in college, or they had a type of training that offers little help in teaching science to young learners. How can elementary-school teachers learn more of the type of science that is suitable for children? How can they gain more confidence in their abilities to guide experiences in this area? The first answer, at least for those already teaching, is inservice education. On the other hand, however, many colleges and universities now offer courses in science education that are specially designed to meet the needs of elementary-school teachers. These courses are available to teachers who return to school to renew licenses or to take additional work leading to advanced degrees.

Inservice Experience for Science Teachers

By NORMAN C. COOPER
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LEARNING is a continuous process. One never stops learning tho he lives to be 100 years old. Teachers must go on studying and learning if they are to keep abreast of the times, and remain qualified as teachers. A classroom teacher's preparation and training does not stop when he gets his degree, or teaching credential, or his first position. In fact, his intensive training just begins, and as far as a teacher has had little preservice training for his particular task or assignment, he has to make up for that lack by more inservice training and learning. Here are a few things that the inservice teacher may do to have fruitful experiences leading to professional competency and growth.

CONSTRUCTIVE SUPERVISION

If a young teacher is fortunate and works under a good supervisor, he will grow from year to year in his ability as a teacher and will be stimulated to study and grow educationally. We need more constructive supervision. The administration should see to it that a teacher's supervision is adequate and that the type of supervision is conducive to professional growth.

STUDY AT A SUMMER SESSION

After the first year of teaching, the teacher usually sees very clearly the weak spots in his training and preparation. This is the time to take advantage of the many good courses offered in the summer sessions of our colleges and universities. An elementary-school teacher, who is weak in science information or technics or who has been unable to teach any science at all in his classes, can in one summer's time obtain enough training in a good science course to enable him to devote part of his time to science instruction, and to integrate science adequately with other subjects. Any teacher weak in the sciences should go to summer school and take a good course in the teaching of science in the elementary school. Often, salary increments are given on the basis of summer-school study and this would be an excellent way to have one's efforts count in two ways.

TRAVEL

Summertime is a good time to travel, and many teachers take advantage of their freedom from classroom responsibilities to take a trip across country or even to foreign lands. The longer the trip the more chance one has to see lands and people, climate and cultures different from his own. A good teacher and an observing teacher—and a good teacher *is* an observing teacher—will not only enjoy the trip to the fullest but will make a little work out of it also. He will take notes and stay long enough at places of special interest to get more than just the obvious facts about the place. If there is a guide handy, he will ask questions and secure printed matter explaining the history, natural phenomena, or cultural interests of the place, with a view to using this new information somewhere in his teaching. In traveling, the classroom teacher should be ever mindful of the geology of the country thru which he travels, the climate should be of studious concern, and the plants and animals of any region should be of prime importance to him as possible material for units in zoology and botany or integrated work with social science units. Someone has said that travel broadens one. It does, and it is an excellent way to gain helpful inservice training for science instruction.

VISITING SCHOOLS

The teacher should visit schools other than his own to see what teachers are doing elsewhere. This visiting should not be just at random, but a particular school should be selected where it is known that excellent instruction in science is being given on the elementary level. Much is to be gained by visiting a teacher on one's own grade level and comparing notes on instruction, seating of pupils, projects or units undertaken, methods and materials, and results and outcomes. Some boards of education allow each teacher two days off during the year, with salary paid, for purposes of visiting schools. This is an excellent practice and one that should be encouraged by classroom teachers and administrators.

PROFESSIONAL ORGANIZATIONS AND MEETINGS

It is more than important that an elementary-school teacher belong to the professional organization that is closest to his work and immediate problems. It is a *must*. A teacher cannot be at his best unless he is in touch with his colleagues and is able to see the overall picture of teaching and its problems. The teacher must see the woods as well as the trees. This is best accomplished in a professional organization where the teachers get together periodically and review

what is happening thruout the country and the profession as a whole. No teacher should miss these meetings if he wishes to grow professionally and be at his best with the newest and latest things in the teaching world. At these meetings the textbook publishers and school-supply houses usually have displays, demonstrations, and free literature that help the teacher materially in selecting aids for his work.

DEMONSTRATIONS

Often at city museums, county and state fairs, Boy Scout and Girl Scout meetings, and college science laboratories, demonstrations are staged which explain, tell why, portray, or depict some phase of culture or learning applicable to the learning which goes on in school. When a teacher has access to such programs, he should, by all means, attend them himself, even if he is unable to take his class with him. Often much valuable information and many worthwhile ideas can be picked up at such demonstrations. No wise, alert, up-to-date teacher will pass up these opportunities which may vitalize the curriculum and make him a dynamic, inspirational teacher.

SCIENCE CONSULTANTS

Every elementary school should have at least one person who is thoroly trained in elementary-school science. This person could act as a consultant for the other teachers in the building or even for the entire school system. This consultant could travel from building to building or from room to room, guiding and assisting all the teachers in the integration of science material with the social studies units. The person could be a general consultant on science or a general curriculum consultant trained in science.

INDIVIDUAL RESEARCH

It is an excellent procedure for a teacher to start out on his own and see what he can do with the science materials for the grade level at which he teaches. He may not know what concepts and subject-matter are suitable for a certain grade, but he can try the material out in his class and see what will work and what will not. It is just as important for him to do research work in this field as it is in any other. Thus, he can build a curriculum for his grade as the months go by, and have a practical and workable one.

The classroom teacher may do research for himself. If he is not too certain of himself in handling science materials, then he should do some research for his own growth and stimulation. He should obtain a good general science text written for the junior high-school level,

University Elementary School, Laramie, Wyoming; photo by Dick Harris

Science in a natural setting was more meaningful to all the children in school.

study the various phases of science, get the necessary materials for the simpler experiments, and practice with them until he feels competent to go before his class. With practice and constant application, the average teacher can become an expert in elementary-school science.

SURVEY OF COMMUNITY

A teacher should not go to a community to teach without spending at least a week in and around the community finding out about the resources and the good learning situations which the community offers. Then, after becoming situated in the community, he should make contacts with industry and labor leaders, policemen, firemen, park superintendents, harbor masters, owners of manufacturing establishments, dairymen, and, if possible, poultrymen and truck gardeners.

Plans should be made to have the pupils of his class visit these places of interest in connection with the various units in the year's curriculum.

SCIENCE CLINICS

Science clinics should be held in each school periodically and the science teachers from the junior high and high school brought in as resource consultants. These people, as busy as they are with their own programs, are always cooperative and understanding. They can be of tremendous help to the teachers in the grades in advising on science content, materials, and methods.

VISITING WORKSHOP TEAMS

Some state departments of education are now organizing teams of leaders to go out from various centers to help teachers in outlying districts. These teams help teachers organize effective science programs and get the programs under way. Every state should have such an arrangement, and the teams should receive financial support both from the state and from the schools which use their services. Usually these teams are available for Saturday conferences or workshops and often go out several miles without charging the school anything. If such a workshop team is available in the vicinity, full use should be made of it.

WORKSHOPS

It is not impossible for elementary-school science teachers to organize and conduct workshops of their own. It is a valuable and profitable experience to organize any workshop, but it is even more valuable to the teachers as a group if they organize a workshop built around their own immediate interests and problems. Of course, many teachers feel they need at least one expert, but even one is not essential. Each teacher can contribute something, and the group will be surprised how much talent, ability, and originality there is in the total group. A building workshop or a citywide workshop in science should prove profitable once or twice each semester.

OPPORTUNITIES UNLIMITED

Thus, the possibilities for inservice growth of classroom teachers in science education are virtually unlimited. Some imagination, above average devotion to duty, a little extra work, and taking advantage of some of the learning opportunities that are open to all teachers are about the only prerequisites to improved science instruction in elementary schools.

Curriculum Project for Preservice Teachers

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AN UNDERGRADUATE course in methods of teaching science in the elementary school must help the student achieve an understanding of: (a) the nature of science and its expanding influence on the character of the life we lead, (b) the function of science education in the elementary-school program, and (c) the growth and development pattern by which science learning is achieved.

The major concern of the instructor in such a methods course is to provide a theme which will bring together the work in each of these three categories in such a way as to develop student interest and produce learning of a practical nature. An instructor may, if he so desires, carry on course work in science methods by developing each of these three factors thru the traditional means of discussion, lecture, and student research. This approach, however, leans heavily upon theory and often produces fragmentary learning.

The responsibility for the course work rests almost exclusively with the instructor; the student's part is quite passive in nature. Such course work lacks the primary incentive which teachers have come to recognize as essential for integrated learning. Instructors in methods courses, therefore, are on the watch continually for the kinds of problem situations which will serve as unifying themes for their methods course work.

A REQUEST FOR HELP

An example of the kind of theme which helps to unify a methods course came to light recently when the teaching staff of one of the elementary training schools asked for assistance in re-establishing its science laboratory room. Discussion with the staff revealed the need for revising the existing science course of study so that equipment and materials required for the school laboratory could be identified.

Revising a course of study is part of the professional work undertaken by teachers in active service. It is a cooperative undertaking that demands constructive group thinking and the consideration of the

scope of the elementary-school program. The preparation of today's teachers, it is felt, should include training in this type of professional endeavor. Working on such a curriculum problem with an experienced teaching staff seemed to present a genuine opportunity for the upper-class students in science methods to obtain excellent professional training in curriculum work. It was with this thought in mind that the problem of establishing a science program was presented to the methods class, and the suggestion made that the course work of the winter quarter be organized around developing such a course of study. What follows is a resumé of such an undertaking in science methods and an appraisal of its value.

ORIENTATION

During the first week the class discussed the curriculum pattern of the elementary school about which the work was being centered, and became acquainted with the task to be accomplished. To help in this orientation, basic materials were prepared for the class. These included a summary of the social studies curriculum with a grade-by-grade summary of the aims, objectives, and areas of interest to be explored. An outline was prepared of the science activities which had been undertaken within this correlated curriculum in the previous year, so that the students would have some idea of what was considered a representative science program in this elementary school. A copy of an earlier outline of physical science activities, prepared some time ago for use in the elementary school, was also included. This had been prepared in great detail as far as suggestions were concerned, but accentuated the physical sciences to the exclusion of the biological or natural sciences. The orientation included lectures and discussion on the meaning of science and the place of science education in the elementary grades.

ORGANIZATION

Part of the class discussion time was given over to developing a tentative schedule of activities which would make it possible to organize the six-grade curriculum plan. It became quite apparent, as the work progressed, that the limited time available made teamwork necessary. The organization decided upon, to apportion the work fairly, included three groups: the first group was composed of potential kindergarten and first- and second-grade teachers; the second group, of third- and fourth-grade teachers; and the third group, of fifth- and sixth-grade teachers.

Students were allowed to pick the group in which they would

work, according to the grades they expected to teach upon graduation. Each group elected its own chairman to help pull its work together and to schedule the small and large group meetings. A general chairman for the three groups was elected to work closely with the instructor. He was to keep a diary of the day-by-day happenings of the small and large group meetings and a record of the meetings of the chairmen of the grade groups.

FOUR MAJOR TASKS

Class activities centered about four major tasks. The first was developing the purpose of science education in the elementary grades. The second was the determination of the general aims of the science program for each grade. The third was the selection of activities which might be used to achieve the aims established for the individual grades. The fourth was the selection of experiments which seemed appropriate for illustrating science principles.

Developing the Objectives of Elementary-School Science

In order to develop student understanding of what was involved in science education, professional resources were examined, including texts in science education and the professional periodicals related to science education.

Thru class discussion and small group meetings, individuals attempted to establish guideposts in science education which could be used in developing the curriculum. Students found it very difficult to agree, at least in discussion, on what would be an acceptable statement of the function of science in the elementary school. It was decided, when this impasse became apparent, to let each student write a paragraph expressing his thinking on the function of science in the elementary grades and turn it in to his chairman.

The chairmen met to read these paragraphs and, on the basis of their reading, to establish a general statement which they felt would be acceptable to the group. The preliminary statement prepared by the group chairmen was mimeographed and given to the members of the class. Finally, after further group discussion, slight changes were made in phrasing and in the organization of the items to be included in the general statement.

The discussions which produced the general statement on the function of science education in the elementary grades made apparent to the group the importance of developing science aims of a sequential nature for each grade. Each grade's work in science education should add to the student's development of science knowledges and skills

and should be in harmony with the general aims established for the total program.

Determining General Aims for Each Grade

The second task involved a grade-by-grade development of science aims which, in the opinions of the students, would permit the growth and development of science concepts in keeping with over-all objectives formulated earlier.

A consideration of the nature and importance of the scientific method and the problem of teaching it to elementary-school pupils convinced the group of the necessity for a continuous science program thru the grades. Learning to observe in an objective manner was considered to be of primary importance in the early grades. Using the technics of observation to gather data from which simple generalizations might be drawn should be the chief objective of the science work in the middle grades. In the upper grades, efforts should be directed toward applying the student's growing ability to observe and to make simple generalizations in recognizing cause-and-effect relationships which exist in his environment.

Each grade group formulated a statement of general aims for its grade. A worksheet containing the aims for all grades was mimeographed for the group. Duplications and conflicts became apparent in discussion but were eliminated in the subsequent reorganization.

The most troublesome aspect of this kind of group work was finding suitable words to convey similar ideas to members of other groups; that is, the ideas were acceptable, but groups found difficulty in selecting the right combination of words or expressions to indicate the similarity of ideas. The improved worksheet was then turned over to the committee of chairmen to work with the instructor to arrive at a final copy of aims and objectives for each grade.

Determining Science Activities by Grades

Individual grade groups now concentrated their efforts on finding the kinds of activities to sponsor within each grade in order to achieve the aims established for these grades. Information regarding suitable activities was obtained from an analysis of the textbooks in elementary-school science written for pupils in the various grades. A review of these books pointed out to the grade groups what the textbook authors thought were appropriate activities in science for elementary-school children. This information was supplemented by an inspection of subjectmatter charts made of textbook series and by information in the professional periodicals.

The primary grades organized their activities on a seasonal pattern, for they felt that in these lower grades science was more of a service subject and should fit into an integrated pattern of primary-grade activities. Some members of the class were able to apply the practical results of their student teaching experiences to this developing process. Worksheets were prepared with the rough draft of activities by grade, and these were mimeographed for group use. Once more in group discussion, errors were brought to light and corrected.

The consensus of the group indicated that for greater service and flexibility the form to be used in the finished copy should be in outline form rather than in narrative style. This, members of the group thought, would make the program more flexible and easier to adapt to given classroom situations.

Listing Experiments, Materials, and Equipment

The final step in the curriculum project was the translation of the information organized in the other sections into budgetary considerations. Developing a statement of material and equipment needs on the basis of an organized and coordinated program is the practical way of establishing a defensible science budget. The danger of

Every teacher had an opportunity to perform at least six different experiments.

Public Schools, Omaha, Nebraska

omission of essential materials or the even greater danger of excessive purchases can be avoided if the requests are made in the light of an acceptable science program.

Having outlined the science activities for each grade, the grade groups drew up a list of experiments and demonstrations each thought would be necessary to convey the science principles embodied in the activities. Each list was broken down in terms of materials and equipment required. Meetings of the total class followed those of grade groups, and duplications were consolidated quantitatively and practical substitutions made. The final form provided an enumeration of materials and equipment which, in view of the program to be offered, were educationally sound and defensible.

The last week of the course was given over to inspecting final copies of the big divisions and combining them for distribution.

VALUES

When this project first got under way, there existed among the students the feeling that the discussions in class were pedantic in character and that the small groups' efforts hinged primarily on a student's liking for "busy work." It was interesting and stimulating to observe the change in attitude once the confusion of getting started had subsided and the nature of the challenge was identified by the individuals in the class. This change in attitude became obvious in the small and large group discussions, for the students directed the discussions along those lines which were pertinent to their self-determined goals.

General explanations and vague references to parts of the program were not acceptable, and students, as well as the instructor, were forced to deal in specific terms, that is, actual experiments and clearly defined principles. The "busy work" of reviewing textbooks took on purpose and meaning. There was no necessity for artificial or academic questions to stimulate group discussions. Discussions were, for the most part, spontaneous and pertinent to the work at hand.

As aims and objectives were developed and the attempt to provide science activities in sequence progressed, educational principles blended into the discussion quite logically, and some students, for the first time, came to see the practical value of philosophy and psychology in professional work.

The pressure of time generated an excellent atmosphere within the class for give-and-take discussion. Students knew that they could not afford any long debates because of obstinacy or opinionated dis-

cussions, and all their efforts were directed toward finding suggestions, ideas, and expressions which would be acceptable to all and not merely identify differences.

The final event in the course was a meeting with the elementary-school staff for whom this curriculum guide of activities had been organized. This provided the students with an opportunity to explain their organization and to defend their choice of science activities. The meeting and discussion made very clear to these undergraduates, who had lived together with this developing project for a full college term, that one cannot present a curriculum to another group and have it mean to them what it meant to those who developed it. As one of the students said after this meeting, "A curriculum has to be lived and its meaning earned. It cannot, in any sense, be 'given.' "

Much has been said about the apprehensions that some elementary-school teachers have for teaching science. This group of students indicated no great fear of teaching science; rather, they manifested an eagerness to get out into the schools to try out their activities and to find what changes they would have to make in the light of experience.

When it came to selecting the general chairman for the various groups, the students were reluctant to elect such an individual until they had a chance to discuss the nature of the job to be done and had a little more time to get acquainted with the members of the class. Caution of this nature is a characteristic of the democratic process that all teachers try to promote, and it was encouraging to see, in this instance, that it was the position seeking the candidate rather than, what most of us have come to see in life, candidates seeking a job.

THEORETICAL COURSES CAN BECOME FUNCTIONAL

A curriculum project, tho done by undergraduates with little or no teaching experience, provides one means of generating student interest and enthusiasm in the science work of the elementary-school teacher. While its success is dependent upon many subtle conditions, any one of which might detract from the apparent value of such an effort, it does indicate that problem situations exist. If these can be properly used, so-called theoretical courses will become functional. It suggests further that the elementary school itself and the problems of its teaching staff afford the collegiate program with a valuable source of situations which could be made use of as practical mediums in which to apply course work in methods of teaching science.

Improving Science Teaching at Arlington School

By SOPHIA A. LEUTNER
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THE content of a science program is all around us, the science educators tell us. This very fact, then, should make the teaching possibilities in science rich and full. By the same token, however, such an abundance of material can be overwhelming. Many teachers have felt the magnitude of the subject and have often approached it with a feeling of doubt or inadequacy. A program, therefore, was planned and conducted this year at the Arlington School to help teachers:

1. Become aware of presentday aims in science
2. Recognize teaching opportunities
3. Become acquainted with problems, procedures, and available materials
4. Organize classroom activities.

UNDERSTANDING THE AIMS OF SCIENCE

This science program was initiated by the viceprincipal at a faculty meeting early in the school year, and was carried thru, with her guidance, at succeeding meetings.

In order to give the program proper direction, the aims of science teaching were discussed by the members of the faculty at the first meeting. The teachers agreed that, of all the aims presented, a few of them were of greatest importance.

In today's world children should be made conscious of scientific problems having social value, and they should be helped in learning how to solve them. They must engage in many and varied activities in order to be aware of the problem, feel the need for solving it, explore its various facets, and finally solve it. Such activities include observing natural phenomena; reading; listening to the radio; watching motion pictures and television programs; interpreting pictures, diagrams, and graphs; and experimenting. While the identification of objects will necessarily enter into problem solving, identification will not be an end in itself. As a result of solving problems, children should gain generalizations and scientific principles basic to their learning. Thru problem solving it is important that children learn to reserve judgment until they have tested a statement by experimentation,

observation, and reading the results of research in the field. They should develop thereby a growing scientific attitude.

Thoughtful teachers attempting to carry on such a program will find that it can be as broad as the universe, including areas of the physical and biological environment. The learning experiences should include those planned by the children and the teacher and may last any length of time according to the scope of the problem and the interest of the individuals. Children and teachers who are science-conscious will also find incidental interests to be cared for in the program.

RECOGNIZING TEACHING OPPORTUNITIES

Discussion centered around ways that classroom teachers can become science-conscious and can equip themselves to solve problems. As teachers prepare to guide children's learnings, they can ask themselves, "What are the scientific aspects of this topic?" They can read children's and teachers' textbooks; science articles in magazines; news stories of fires, floods, weather, or other phenomena; pamphlets and booklets published by government agencies or industrial concerns. They can attend lectures, watch television programs, and listen to radio broadcasts. These teachers will soon find themselves ready and able to guide the children as they pursue their interests in science. The first-grade teacher will know how to help the children learn to care for a rabbit. Another teacher will be able to help children read weather maps and understand their importance. Knowing how to test soil and understanding its importance in planting a small garden or in operating a large farm will be vital learnings. A knowledge of earthquakes and volcanoes—where they happen, their causes, and their results—will clarify for children the problems faced by people living in certain areas of the world.

Children will bring problems of jet propulsion, atomic energy, medicine, chemistry, and myriads of other topics into their classroom discussions. When a child initiates such a problem, the interest of the others is usually keen. A wide-awake, well-prepared teacher can guide the children thru a wonderfully alive learning experience. It will, of course, be necessary for the teacher to select the kinds of ideas that children will be able to understand and to have them carry on the kinds of activities that will be meaningful to them.

PROBLEMS, PROCEDURES, MATERIALS

Members of the school staff took part in some meetings, and well-qualified people from wider educational circles proved a real stimulus at others.

Using Recent Books

Teachers used recent books by authorities on science education and gave reports on the following types of procedures usable on any grade level and with many different kinds of programs: experimenting, observing, taking field trips, and using audio-visual aids. In each report and in the discussion that followed, it was emphasized that there should always be a real purpose in the minds of the children for carrying on any activity. Careful preparation by the teacher and children is necessary to make the experience meaningful. The children should have an active part in thinking thru the problem and in carrying on the activities leading toward the solution.

Reporting on Actual Programs

At later meetings teachers on primary and intermediate levels gave detailed reports of programs that they had carried out with their children. A primary teacher had based her science program on the weather and the changes it causes. The children observed the trees and bushes growing around the school; they watched the falling seeds in autumn, the bare trees in winter, and the tiny buds in spring. They found out how water becomes ice or steam, and what happens when it does. What wind is and its effect upon people, their work, other living things, transportation, and buildings proved a topic of great interest. Thru all their work, these children were constantly observing their surroundings, reading, and experimenting. "Let's try it to see what happens," became a familiar suggestion in that classroom.

A teacher of the intermediate grades reported on learnings and activities of his children in relation to the history of the earth and its presentday significance. These children were interested in the forces that have worked upon the earth thru the ages: volcanoes, earthquakes, wind, water, and high and low temperatures. The action and results of these forces were studied thru the use of motion pictures, filmstrips, slides, photographs, books, diagrams, graphs, experiments, and models. The science interests of these boys and girls became more significant and vital when the Hibok Hibok volcano erupted. The destruction wrought when so mighty a force is released helped these sixth-graders understand such power. The efforts of the government to control erosion thru better farming methods and thru forest conservation took on new meaning for them.

A third-grade teacher reported on how the children in her class developed the scientific aspects of the study of China. They learned that water can be lifted by wheels onto fields and that sailboats can

University Elementary School, Laramie, Wyoming

Attractive bulletin boards furnish strong motivation.

be driven by the wind. The power derived from these sources was demonstrated thru the use of simple models. The cultivation of tea, rice, mulberry trees, and silkworms, upon which China's life and culture are so largely based, was studied thru the use of exhibits, pictures, and reading materials. These, and other topics, made the study of China much more vital to these children.

Unique Language Problems

A member of the supervisory staff whose special interest is language arts discussed with the faculty the unique problems children confront in reading science material. The children must understand a very specialized vocabulary in order to enlarge their knowledge and understandings of scientific phenomena thru reading. Children must be guided in their reading to select important ideas and to

organize them in relation to the problem to be solved. Such reading is difficult on any level. It is necessary, therefore, that teachers exercise careful judgment in selecting material for children to read.

Visiting Expert

A science instructor at the State Teachers College in Towson was invited to participate in one meeting. He gave specific suggestions for a science program having a seasonal approach. He traced the changes that occur in different types of plants and trees thruout the year. The different planets in the fall, winter, and spring skies make an interesting study. The living habits and, in some cases, even the appearance of animals change with the seasons. Weather changes are important to note if we are to understand what occurs and how these changes affect man.

This science instructor pointed out that a worthwhile science program can be carried on with simple materials. He showed how germination can be demonstrated with blotting paper and saucers. The construction of an animal cage from a wooden framework with screen floor and sides was illustrated. The keeping of charts by the children on weather, gardening, or other activities was encouraged. He recommended that the teachers use references showing how science equipment can be constructed from inexpensive and easily procured materials found in the five-and-ten-cent stores, hardware stores, or in many kitchens. How meaningfully materials are used is more important than how elaborate they are.

Science materials available in the school and community, or easily secured by mail, were displayed and discussed. These materials included textbooks, reference and library books, visual aids, equipment for experiments, pamphlets, booklets, charts, and maps. Teachers were encouraged to use books and materials with any group wherever they filled a need, regardless of how they might be labeled as to grade level or topic. Thoro knowledge of the materials on the part of the classroom teacher is necessary for their most effective use with children.

ORGANIZING CLASSROOM ACTIVITIES

In addition to the program carried on in the faculty meetings, the viceprincipal worked with teachers and children. In some instances help was given to teachers in planning units of work. In this joint planning teachers were encouraged to identify the science problems that arise or could be suggested in a classroom; they were urged to be constantly aware of scientific principles, and to plan

activities that would encourage the use of the scientific method. Demonstrations of procedures and materials were given in classrooms from time to time.

One teacher and the viceprincipal worked cooperatively with different groups at the same time in one room over a period of several days. The children were divided into interest groups to find out what the effect of water is upon the earth. The groups studied these phases of the topic: the effect of rivers and waterfalls, the effect of erosion, the formation of underground caverns, the formation of various kinds of sedimentary rocks. Each group identified, defined, and worked thru its problem. Help was given in locating and securing many kinds of materials and in making the most of their use. Each group used some visual or concrete material, and some reading material, and performed experiments. Guidance was given in securing, organizing, and verifying data. After the groups had worked thru their problems, their findings were shared with the rest of the class. In presenting their material the children tried to make their problem and its solution clear thru the ideas they had organized and by using the materials they had explored or developed within the group.

EVIDENCE OF RESULTS

What are the results of such a program? The first result is that teachers were made aware of presentday aims, materials, and activities in science teaching. More important, however, were the ventures of some teachers in identifying and working thru problems never before attempted.

Enthusiasm and interest ran high, and, of course, with it, great satisfaction. In one first-grade class the children were eager to tell the best ways to care for their pets at their pet show. In another first grade the children watched daily for sprouts to appear from the seeds they had planted. These children had learned the requirements for seeds to grow and they had taken part in caring for them.

The intelligent questions asked by the members of a fifth-grade class, when they went to the weather bureau, showed a keen insight into their problems. In the sixth-grade class that studied the earth children were constantly examining rocks with hand lenses and trying many tests on them for identification. A parent of one boy in this class reported that her son had said that he thought "this geology" was wonderful. Satisfactions of this kind were repeated many times thruout the various classes of the school. Such experiences should make the children and teachers alike not only conscious of science opportunities, but also confident in attacking science problems.

We Conducted Our Own Inservice Program

By FRANK H. GORMAN
and MARGARET F. O'BRIEN
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SOMETIMES we think we must go afield to obtain help in making ourselves more proficient in the job we are called upon to do. Frequently, too, the needed help is not always obtainable, and as a result nothing is done.

This is an account of the way in which a corps of classroom teachers, who knew their limitations in teaching elementary-school science, decided to pull themselves up by their own bootstraps. What these teachers did proved to be one of the most inspiring, confidence-giving experiences the staff has ever had.

THE TEACHERS NEEDED HELP

"How do you go about setting up a science experiment?" "I don't know anything about electricity." "What do you do when an experiment doesn't come out right?" These were some of the questions and comments of teachers as the program in science was launched in the elementary schools of Omaha. Altho science had been taught in some of the schools, and in some places a pretty good job had been done, many teachers lacked background for teaching the subject and wanted some practical help.

To be sure, a new set of basic science texts with excellent manuals had been provided, and science kits had been furnished each school. But even with this equipment and the suggestions of "the what" and "the how," many teachers felt insecure and requested demonstrations or workshops thru which they could obtain further aid.

PLANNING THE WORKSHOP

Many requests called for guidance in conducting experiments and in handling the necessary materials. A number of teachers expressed an actual fear of certain activities. After considerable deliberation, the committee approved the idea of a workshop in which classroom teachers would have the opportunity to actually perform the experiments. This immediately raised a question about leadership.

In the course of the discussion someone facetiously suggested that the committee members might have to furnish the leadership. This

idea was seized upon by the two members who had been science teachers and who had great faith in the ability of the committee. They began a campaign, pointing out the advantages of the committee's doing the job. It took much persuasion on their part, but the committee finally agreed to venture into this new experience.

As the group saw it, the workshops should be kept on a voluntary basis. Since 18 teachers could be accommodated easily in each workshop, the committee needed to plan for only three sessions in order to take care of all who would be involved. First, they zoned the city and obtained permission to hold the workshops after hours in a school building centrally located in each zone. They scheduled the workshops on a selected day in three consecutive weeks.

The science committee then collected sufficient equipment for each center and requisitioned adequate supplies. In preparation for staffing the workshops, they held several meetings in which each member of the committee thoroly acquainted himself with the ex-

Teachers gained confidence in their ability to teach science.

Public Schools, Omaha, Nebraska

periments and the method to be used in directing the participants. They also prepared printed guides to put in the hands of workshop members.

WORKSHOP IN OPERATION

Six tables to accommodate eight people each were set up. On each table were placed the materials for the experiment to be conducted there. For example, one table had eight microscopes; another had candles, lampshades, and cardboard covers. The tables were numbered and one committee member was placed in charge of each. As a teacher arrived he was given a number indicating the table where he was to begin.

The committee member acting as chairman for the day briefly discussed the plans for the workshop and introduced the other committee members. Fifteen minutes were allowed for the work at a table, each worker moving on to another table at the end of that time. In this way everyone had an opportunity to perform at least six different experiments.

OUTCOMES

Following the workshop, questions designed to help evaluate the experiences were distributed to the participants:

Do you approve of this type of workshop?
What improvements do you suggest?
After we have studied your suggestions for improvement, should we plan other science workshops for next year?

The replies gave these results: (a) unanimous approval of this type of inservice experience for teachers, and (b) recommendations that a similar service be extended to other grade levels.

In evaluating the project, the committee members, who obviously enjoyed the activity, revealed growth in understanding of and confidence in their own skill and capacity as science teachers. Most of them were surprised at their success in giving democratic leadership to other teachers in such an endeavor.

The supervisory and curriculum staffs noted other significant benefits as time went on. The continued growth of the leaders and participants, following the workshop, was highly gratifying. The number of volunteers for service on the science committee increased remarkably. Noteworthy, too, was the cordial acceptance of leadership by fellow teachers. Most important of all was the emergence of science instruction from a passive reading-type program into a "learning by doing and thinking" experience.

Preservice Experiences in Science

By GEORGE GREISEN MALLINSON
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IT HAS been amply evidenced in earlier chapters that science has finally earned its place in the curriculum of the elementary school. This place, however, was earned only after a hard struggle. Further, it is clear that today most elementary-school teachers teach some science in one form or another, and to a greater or lesser degree.

FINDINGS OF RESEARCH

A survey of the literature in the field of science education, however, indicates that investigations dealing with the training of teachers to teach elementary-school science are few and far between. The few recent investigations that deal with the training of elementary-school teachers to teach science indicate an appalling disregard of their needs in this area. In essence, these investigations reveal the following facts:

1. In about two-thirds of the states it is possible for a teacher to be certified to teach in the elementary grades without having had any courses in science in college.
2. In all but five states it is possible for a teacher to act as a specialist or consultant in the teaching of elementary-school science without having had any academic credit in science in college.
3. The critic teachers in the elementary training schools of teachers colleges frequently lack adequate backgrounds in subjectmatter and methods of science. Hence, it is unlikely that they offer science experiences to student teachers that are as effective as may be desired.
4. Many critic teachers believe that science experiences are best treated incidentally and contributory to the program of social studies. In such cases, the major objectives of the teaching of elementary-school science may be disregarded.
5. Elementary student teachers generally find the typical subjectmatter courses in college science, especially those in physics and chemistry, of little value in teaching elementary-school science. Hence, where possible they try to avoid such courses. Since few courses in science of value to them are offered, they frequently take no courses in science at all.
6. While many elementary student teachers believe themselves sufficiently competent in science subjectmatter to teach it effectively, scores that they obtain on tests in general science do not indicate such competence.
7. Where elementary student teachers are able to take survey courses in physical or biological science, they state that such courses generally prove effective in meeting their needs for subjectmatter in science.

SURVEY COURSES

In view of the conclusions just stated, and in light of the statements of needs in the previous chapters, it is clear that some changes need to be made in the science programs in colleges that train elementary-school teachers. The program which follows is suggested as a means for meeting such needs and is recommended for all elementary-school teachers.

A Survey Course in Physical Science

This course should be developed cooperatively by the science and education departments of the teachers colleges and should be taught in the subjectmatter departments.

It should be developed around the major objectives of science teaching as stated in the Forty-Sixth Yearbook of the National Society for the Study of Education.[1] These objectives, in effect, are:

1. The attainment of functional information or facts
2. The functional understandings of the important principles of science
3. The development of scientific attitudes
4. The development of skills in problem solving, or scientific method.

These objectives, of course, are valid for science teaching at the elementary-school level, as well as for survey courses in physical science. The objectives, however, will be much more completely developed in the survey courses than in the courses in the elementary school.

The topics for the development of the objectives will be selected from all fields of physical science: physics, chemistry, astronomy, geology, and meteorology. They will be selected on the basis of their values in developing the objectives already stated, and in terms of the extent to which they are parts of the life experiences of the future elementary-school teachers.

The survey course in physical science will provide experiences in the laboratory that will enable the future teacher to use common materials likely to be available in the elementary school. These experiences should be presented as inductive laboratory exercises.

A Survey Course in Biological Science

This course will meet all the requirements of the survey course in physical science, except that the topics will be chosen from the various areas of biological science: botany, zoology, health and safety education, and conservation education.

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[1] National Society for the Study of Education. "The Objectives of Science Instruction." *Science Education in American Schools.* Forty-Sixth Yearbook, Part I. Chicago: University of Chicago Press, 1947. Chapter 3, p. 19-40.

AREAS TO BE COVERED BY SURVEY COURSES

The following major areas may be desirable as nuclei around which to develop the survey courses. While there is not sufficient research evidence to prove that the list contains all the most important areas, it seems to contain those areas that are ordinarily found in elementary-school science.

Physical Science

1. The nature of science and scientific thinking—the use of the scientific method in advancing the frontier of knowledge
2. Air—its physical and chemical characteristics and the uses made of them
3. Water—its physical and chemical characteristics and the uses made of them
4. The production and utilization of heat energy
5. The influence of weather and climate on living things
6. The universe and the relationships among the various bodies in it
7. The earth and its physical resources
8. Geological forces and their effect on the earth's surface
9. The production and utilization of light and other forms of radiant energy
10. Matter and energy, and their relationship to one another
11. Using electricity for power and communication
12. Modern methods of transportation
13. Conservation of energy and of our physical resources

Biological Science

1. The problems of survival of all living things
2. The varieties of living things—simple to complex
3. The characteristics and uses of the various groups of plants
4. The characteristics and uses of the various groups of animals
5. Man and his place in the biological world
6. The effect of seasons, climate, and geography on the activities of living things
7. How man obtains and uses food
8. The behavior of man in adjusting to the living and nonliving things in his environment
9. How plants and animals reproduce
10. Using biological resources wisely
11. The history of life on the earth

A COURSE IN TEACHING SCIENCE

The two survey courses should be followed by a course in "Teaching Science in the Elementary School," to be taught by a person who is primarily an educator, who has had wide experience as a teacher of children, and who possesses a broad background of scientific subject-matter. Such a course would cover the following areas:

1. The philosophy and objectives of the teaching of science in public schools from kindergarten thru Grade XII
2. The growth of the modern science curriculum—the roles of subject-matter and methodology
3. The place of science in the elementary school (Special science classes, integrated science experiences, the "core program"; this should include an examination of various courses of study.)
4. Effective use of laboratory experiences at the elementary-school level
5. Audio-visual materials for elementary-school science
6. Selection and evaluation of textbooks and other published materials for elementary-school science
7. Field trips and the use of community resources
8. Evaluating the outcomes of elementary-school science
9. Club and hobby activities in science for elementary-school children
10. Using the schoolroom and other available space for science experiences
11. Professional organizations and publications concerned with elementary-school science
12. Graduate study and inservice training of value for teachers of elementary-school science.

EXPERIENCES SHOULD MEET TWO CONDITIONS

These proposals may, at first glance, seem extensive. Yet they would require only a small fraction of the total credit hours devoted to the training program of elementary-school teachers. In addition, they encompass many areas, both academic and professional.

It is impossible in the space allotted here to indicate precisely the principles and topics that should be included in the survey courses, to indicate how they might be organized under the listing of areas, or to suggest specific teaching technics. It is reasonable to state, however, that such experiences can be effective only if two major conditions are met:

1. That the elementary student teachers be given the opportunity (a) to learn inductively in the subjectmatter courses, and (b) to participate in laboratory experiences in which the main objective is to solve problems, not merely to verify scientific facts.
2. That the critic teachers at the elementary-school level be cognizant of, and sympathetic with, the major objectives of science teaching at the elementary-school level. Further, the critic teachers should place areas and principles of science on a par with those of other subjectmatter fields as possible nuclei for various integrated experiences.

Developing a Feeling of Security in Science Teaching

By JUNE E. LEWIS
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THERE are many elementary-school classrooms today in which either very little science or no science at all is being taught. One of the most common causes of this condition seems to be the classroom teacher's fear of science, and this fear, in most cases, can be traced to inadequate training in science.

Some teachers who feel insecure in teaching science report that they do not remember having had any science while they were in elementary school. A number of them state that they vaguely recall the general science course they had when they were in the eighth or ninth grade. Most of them admit that, whenever possible, they avoided this field in high school and in college. Consequently, the conscientious teacher faces the dilemma of knowing that he should teach science, but, being human, continues to avoid it because he feels insecure.

HELPING THE TEACHER GAIN CONFIDENCE

The problem that the administrator must solve is how to help the classroom teacher attain the security necessary to enable him to enjoy working with children in science. Some of the following suggestions may help:

1. Give the teacher a word of encouragement whenever you see any signs of this subject being taught in his classroom.
2. It helps to know that others are in the same boat. Let him know that some teachers with very limited science backgrounds have been successful.
3. Assure him that even a small start is better than none at all. Suggest that he make a beginning in some area in which he feels a measure of confidence. The initial attempt could be a very modest one such as the variety of living things that may be found in the school yard or the park, the effect of seasonal changes on some nearby tree, or planting seeds and watching them grow.
4. Let him know that he will not "lose face" if he is unable to answer all of the children's questions. Children ask numerous questions that are among the imponderables. Providing a simple answer to some can even stump the experts. A child's faith in his teacher grows when the teacher says, "I don't know, but I'll help you find out!"

5. Tell him about other teachers who have greatly enjoyed exploring unfamiliar areas of science with their children. Give him the courage to make similar explorations by making certain that he knows that the measures used for evaluating the worth of children's experiences in other areas of knowledge also apply to science experiences.
6. Inform the teacher that there is no unique method for teaching science. Teachers frequently ask, "How shall I teach it? I have no idea of how to begin!"

A teacher needs to know that the same method that is used to initiate interest in arithmetic, the language arts, or any other subject in the school curriculum can be used in teaching science. A casual statement about the weather, some child's puppy, the birds in the school yard, or the moon will start a flood of questions and comments. A hobby show or a science fair will provide a wealth of opportunities.

USING TOYS IN SCIENCE

Children's toys illustrate many important scientific laws which the boys and girls will enjoy rediscovering with their teacher. "Freddie," a toy rubber frog, is attached to a long rubber tube that has a hollow bulb on the end of it. "Freddie" swims when his back legs are filled with air. By squeezing the hollow bulb, air is forced into the back legs, and as the legs straighten out they push against the water, like a pair of oars, and drive the frog forward. "Susie," the plastic duck, has a rubber tube with a hollow bulb attached to her too. Susie wobbles when you squeeze the bulb. It was easy for the children to see why Freddie swam in the water, but they couldn't see what was inside the plastic duck to make her wobble. But they had fun guessing what might cause it, and tomorrow they are going to take the duck apart and find the solution to their problem.

As soon as the children know that their teacher is interested in science and is willing to follow thru some science experiences with them, there will never be further concern regarding how to teach it. When that time comes, the teacher's chief concern will be, "Which interest shall we follow next?"

DIVERSIFIED INSERVICE TRAINING

After a satisfying tryout in science teaching, teachers should be encouraged to participate in a diversified inservice training program. Such a program might consist of the following:

1. Visits to other classrooms
2. An evaluation of the total school program
3. Discussions with elementary-school science consultants
4. Science demonstrations
5. Professional workshops and courses.

A teacher's feeling of security in his ability to teach science can be increased by visits to other classrooms in which science is being taught. These visits should be made to classrooms where teachers are working with children who have similar backgrounds.

A series of faculty meetings devoted to the major areas in the total school program has given the classroom teacher insight into the work done in the various grades and has developed a feeling for the need for more careful evaluation and continuity. Such meetings have resulted in committees of faculty members reorganizing the school's program on the basis of its specific needs.

Other faculty meetings have been devoted to the examination and evaluation of elementary-school textbooks and science curriculums organized by other school systems. Some schools have arranged to have consultants in elementary-school science spend one or more days with them working with small groups of teachers.

Sectional meetings during large conferences of teachers have provided opportunities for classroom teachers to see demonstrations of simple experiments that can be done with inexpensive or homemade equipment.

Since security comes with a teacher's acquiring the "know-how," he should be encouraged to attend workshops and take courses that are designed to meet his specific needs. Some elementary schools hold workshops during the first week of the school year. These workshops are led by educators familiar with teachers' problems. A number of universities and teachers colleges are offering courses and workshops of a similar nature which teachers may take for either undergraduate or graduate credit.

Recently, 30 teachers in an elementary school enrolled in a general science course offered by a teachers college. Theoretically, the course was limited to four two-hour periods weekly during the summer session. Actually, the laboratory, in which the course was given, was open daily from early in the morning until late in the afternoon. These teachers discovered that science could be fun, that science could be practical, and—best of all—that they could understand it!

Many opportunities were provided in this summer course for teachers to work with materials and equipment suitable for the elementary school. During the first week the group became oriented to the laboratory in which they were to work and to the kinds of problems in which the group was interested. At the end of this period, the class divided itself into four groups: kindergarten and first grade; second and third grades; fourth, fifth, and sixth grades; and seventh, eighth, and ninth grades. Each of these groups organized two or more

science units that they could use during the coming year. The units contained background materials for the classroom teacher and the children, experiments and other visual aids for the development of major science learnings, equipment, and bibliographies.

Each of the four groups in the course taught one of their units to the other three who pretended that they were the children for whom the unit was planned. The class enjoyed this method of presentation; they had many good laughs over some of the questions and the discussions that followed; and they gained confidence in their ability to teach science.

At the end of the course the class held an exhibition of its work and invited the entire summer school to be its guests. During this exhibition, the class demonstrated a number of interesting experiments as well as the equipment, visual aids, and reference books that would be useful in teaching the units.

THEY FELT MORE SECURE

In the fall these 30 teachers returned to their respective classrooms. Did they feel more secure in their ability to teach science? Of course, they did! But they still feel the need for more help and more assurance. One successful summer's experience cannot eradicate completely the feeling of insecurity that had been developing since their high-school days. The administrator's interest and encouragement will continue to be important determiners of the teachers' enjoyment of ventures into science with children.

. . . the power of education to improve the material well-being of a nation has been demonstrated during the last one hundred years in several places in the world. That it also has power to shape the aspirations and purposes of a people has been demonstrated, however unworthily, in the fanatical acceptance of the totalitarian ideology by our recent enemies. That it can be an instrument of sufficient power in our free society to enable our nation to achieve the social equality, the economic justice and harmony, the worthy use of technical knowledge, and the world-mindedness that the security of the nation in this age requires, has still to be demonstrated.

—*Schools for a New World*, Twenty-Fifth Yearbook, American Association of School Administrators.

A Science Week End

By RUTH M. NORTHWAY
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TEACHERS who need experience as a background for elementary-school science teaching can combine "business with pleasure" in a science week end. Elementary-school teachers at Kingston, New York, tried it last September, and the interests and ideas which they gained are now in evidence in classrooms thruout the city.

The participants included classroom teachers, administrators, local laymen, an elementary-school science specialist from Columbia University, and members of the New Paltz Teachers College faculty.

PLANNING THE WEEK END

The planning of the week end consisted of the following steps:

1. The circulation of an opinionnaire to discover whether classroom teachers were interested and to determine the areas in which they felt they needed help
2. Renting a guest house in the Catskills which had facilities for lodging and meals
3. Planning the entire program around the needs of teachers as indicated by the opinionnaire
4. Publicizing the program in the schools of the area (All were invited to take part in the activities.)
5. Collecting various types of materials to be placed in the exhibit building, which, in this case, was an unused garage. Teachers sent descriptions of classroom activities; science bulletins and books were displayed; equipment for experiments in science was set up for use; and natural specimens were available for study.

PROGRAM

The program for the week end consisted of the following activities:

1. An opening lecture by Dr. Gerald Craig, one of the country's leading science educators from Teachers College, Columbia University (All schools were dismissed at 2 p.m.)
2. A dinner Friday evening with a local speaker whose subject was "Birds of Ulster County"
3. A choice of a Saturday morning bird walk or nature hike. In each case suggestions were given for using the knowledge gained and the materials collected in elementary-school classrooms.
4. A noon hour of fellowship and "good eating" which included over half the elementary-school teachers of the city

5. An afternoon devoted to demonstrations of experiments suitable for the elementary school: making a terrarium, and an explanation of jet propulsion about which we have heard so much. A trip to a small waterfall nearby, where rock and fossil specimens abound, completed Saturday afternoon.

6. On Saturday evening dinner was prepared and served at an outdoor fireplace. This was followed by singing and by "star-gazing" thru a portable telescope, which proved enjoyable as well as instructive.

7. On Sunday morning groups were free to attend the local church, to examine filmstrips and other materials in the exhibit room, or to just relax

8. On Sunday, after a noon luncheon, the group heard a talk on "Atomic Energy." Laymen from the community also attended this session.

EVIDENCE OF EFFECTIVENESS

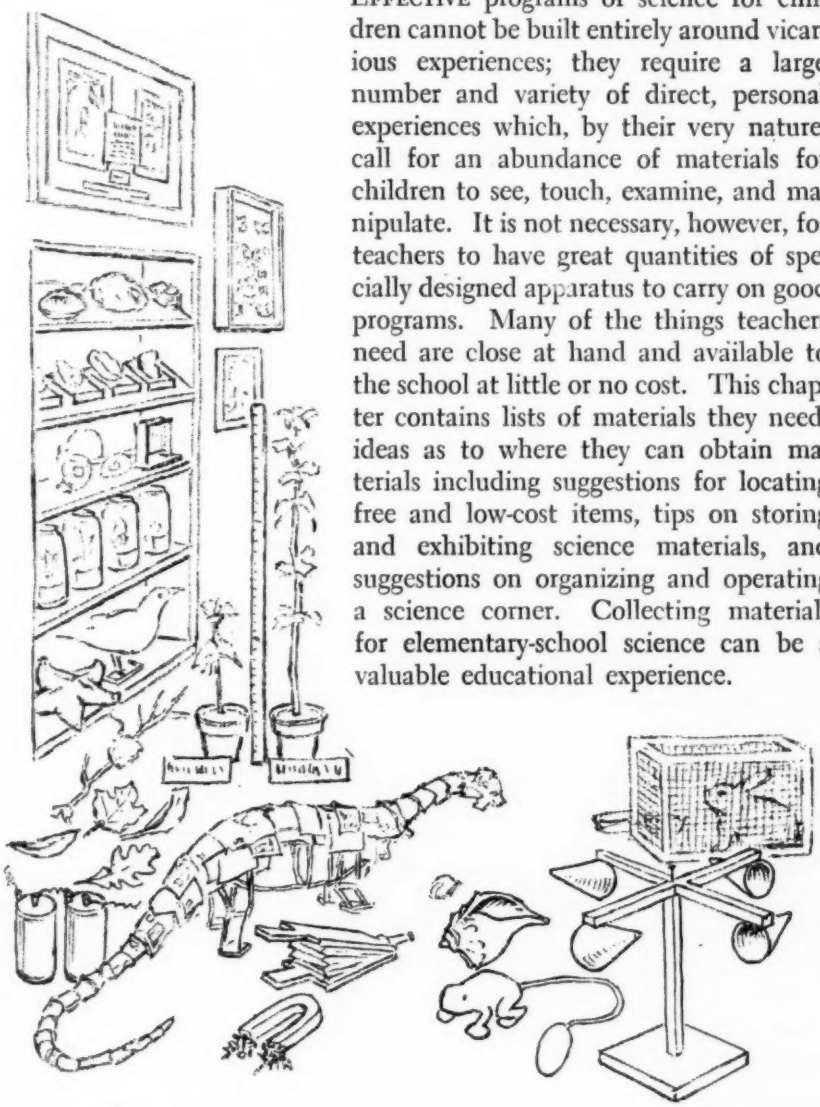
Teachers left the meeting with many new ideas and with renewed enthusiasm for their work in science. In local elementary schools one can now observe extensive use of field trips, science corners, exhibits, and experimentation, much of which is evidence of the effectiveness of the science week end.

Children are as much entitled to open air, to open places, to acquaintance with nature and her wonders, as they are entitled to justice and love and a fair chance. A child should intimately know rain and wind, grass and trees, gnats, butterflies, toads, tadpoles, birds and their nests, flowers and their haunts, hayfields and meadows, haystacks and cellar doors, rain-barrels and the attics of barns during stormy days; they should have rabbits and chickens and squirrels and dogs for their companions and friends; they should be acquainted with dog-fennel and sassafras, they should dig caves and explore forests and sail the ocean of a millpond in the galley of a soap-box raft; they should be out where every breath comes freshened and stimulating from the plain or the hills, where the sun strikes into their little bodies directly, where dew can moisten their feet and snow fall on their glowing faces and the wind lift and rumple their hair!

—LUTHER BURBANK, *The Harvest of the Years*, Houghton-Mifflin Co., 1931.

CHAPTER NINE

Equipment and Materials



EFFECTIVE programs of science for children cannot be built entirely around vicarious experiences; they require a large number and variety of direct, personal experiences which, by their very nature, call for an abundance of materials for children to see, touch, examine, and manipulate. It is not necessary, however, for teachers to have great quantities of specially designed apparatus to carry on good programs. Many of the things teachers need are close at hand and available to the school at little or no cost. This chapter contains lists of materials they need, ideas as to where they can obtain materials including suggestions for locating free and low-cost items, tips on storing and exhibiting science materials, and suggestions on organizing and operating a science corner. Collecting materials for elementary-school science can be a valuable educational experience.

Materials for Elementary-School Science

By ROBERT STOLLBERG

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IT IS by now a well-established principle that instruction in elementary-school science should involve an abundance of student activities related to the science being learned. Many of the ideas of science, such as the nature and occurrence of centrifugal force and the unfolding of a growing leaf, can be grasped only when the learner has had actual experience—often physical contact—with the materials being studied. Indeed, some of the objectives of science education—skill in problem-solving, use of scientific attitudes, development of interests and appreciations—can be achieved only thru direct experience; mere words and other vicarious experiences seem to have little or no effect.

It should be emphasized that this notion of an experience-laden science program stands in sharp contrast to the older pattern of unembellished verbalization in science. To be sure, reading, teacher presentation, discussion, student reports, and the like all have a rightful place in elementary-school science instruction. But modern educational practice also calls for an abundance of student activities. These may take the form of demonstrations, experiments, construction projects, excursions, dramatization, or collection, among others. Such activities are often manipulative in nature—they should be investigational wherever possible—but the important thing is that they should be *direct, purposeful, participative experiences for youngsters.*

Altho the principle of learning science thru experience is almost universally *accepted*, it is by no means universally *practiced*. Many elementary-school teachers, if they teach science at all, confine the children's learning experiences to reading in the science books, which are often used merely as readers. They ignore current and local science; they restrict their means of communication with students strictly to verbal symbols.

There are many excuses—often genuinely severe obstacles—which stand in the way of improved science teaching. Some teachers lack background; still more lack confidence in the background which they do possess, which is often more adequate than they imagine. Some teachers lack the time, the space, or the equipment needed to provide a real experience program in science education. Some teachers simply

lack "know-how" in selecting suitable experiences for teaching science. If teachers can be helped to overcome even one of these impediments to good science teaching, the cause of elementary-school science will be materially promoted.

When teachers do provide meaningful science experiences for children—experiments, demonstrations, projects, excursions, and the like—they inevitably find themselves dealing with a large quantity and variety of concrete teaching materials. They find themselves involved with equipment, specimens, models, collections, and endless kinds of other items. Those who do not have these aids to learning are severely handicapped. At the present time, most school systems do not automatically provide a generous supply of these teaching materials. Unfortunately, many teachers feel that the acquisition of such equipment is quite beyond their reach, not only because of the cost involved, but also because of the science background required. Actually, these fears are almost completely groundless. Furthermore, the collecting of teaching aids in science can be a thoroly pleasant, enriching, and instructive activity for teachers and students alike.

The purpose of this article is to help elementary-school teachers and administrators provide their classes with the kinds of equipment needed for a program that is properly enriched with direct, meaningful experiences.

SCIENCE KITS VERSUS LOCALLY OBTAINED MATERIALS[1]

There are on the market several commercial kits of instructional aids in elementary-school science. The prices of three well-known kits are $33, $36, and $41.50.

The similarities among such kits far outnumber their differences. Each emphasizes physical science materials rather than life science materials; each contains a variety of simple chemical, electrical, mechanical, and optical items characteristic of science supply houses; each is housed in a sturdy case with handles; each includes a manual of instructions specifically tailored to the materials in the kit.

There are many definite advantages of such sources of materials. These advantages have been discussed by the writer elsewhere. Such kits will be neither endorsed nor condemned here. Rather, suggestions will be made to help teachers provide science equipment, either to supplement such kits or to substitute for them, as indicated by local needs and policies.

[1] Adapted from Stollberg, Robert J. "How Can Teachers Obtain Equipment for Elementary School Science?" *California Journal of Elementary Education* 21: 47-52; November 1952.

Actually, the use of locally obtained materials for science instruction need not be considered as a "second-best" solution to the equipment problem. On the contrary, there is much to be said for the improvised, the homemade, the commonplace as aids to instruction in science.

Local Collections Can Be Adapted to Local Needs

Teachers who undertake the acquisition of their own elementary-school science materials can adapt their collections along lines indicated by student needs and interests, teacher objectives, and incidental equipment already on hand. Thus, if pupils are particularly interested in electricity, the local collection can emphasize appropriate materials. Again, if a school happens to have test tubes, beakers, rubber and glass tubing, and sources of heat already on hand, the local collector can avoid the unnecessary expense of duplicating these items. Furthermore, the local collector can provide an equitable balance between materials for learning in physical science and those for learning in life science, a feature of which commercial kits cannot boast.

Local Collections Can Be Inexpensive

The great majority of items found in commercial elementary-school science kits can be obtained from the local hardware, variety, grocery, and drug stores. What is more, the dollar spent on local collections purchases considerably more science teaching potential than does the dollar spent on a commercial kit. This is true, of course, because the local collector does not have the overhead of the commercial supplier, and because the teacher, if resourceful, can draw on donated, improvised, and homemade supplies, virtually without cost. Of course, this comparison takes no account of the chest or the instruction manual supplied with commercial kits, nor does it take into consideration the local collector's time and effort required to locate and secure the desired items.

Local Collections Can Emphasize Simple, Familiar Materials

An amazing quantity of elementary-school science can be learned thru experiences involving common items found around the school and home. Screen door springs, medicine droppers, modeling clay, rubber bands, flashlights, balls of all kinds, balloons, roller skates, silverware, toys, tools, musical instruments, and kitchen utensils are but a few examples of readily available materials useful in teaching elementary-school science. Of course, there are many occasions when specialized, sometimes scientifically specialized, equipment is highly desirable. When needed, such items as Pyrex glassware, rubber and glass tubing, test tubes, rubber stoppers, a good thermometer, litmus paper, and a

powerful magnet are well-nigh indispensable. There is no disagreement here with the policy of using specialized apparatus *where necessary*. The quarrel is with the practice of using unfamiliar, often grotesque, equipment *when it is not needed*.

There is much to be said in favor of using simple everyday materials whenever possible. There are coldly practical reasons such as economy and ready availability. There are also some very cogent psychological reasons. Every piece of strange apparatus imposes an obstacle in the path of the learner—he may even have to use a new name for it. In any event, his attention to the science principle under consideration is inevitably reduced by the mere presence of the unfamiliar materials.

Most important of all, however, is the effect of specialized science equipment on the learner's concept of the role of science in daily living. Highly specialized experimental materials lead children and adults to the notion that science is only for specialists, that science is strictly a laboratory subject. It is desirable to teach youngsters that science is an everyday thing—something they constantly encounter, use, and enjoy in the daily walks of life. Accordingly, it is clear that teachers should strive to teach science with materials encountered at home, at work, and at play; for example, foods, tools, and toys. To put it another way: If possible, why not use a milk bottle instead of a Pyrex flask? Why use glass tubing when a soda straw will do?

Local Collecting Is in Itself an Educational Process

One of the unsung virtues of local collections of materials for elementary-school science is the rich educational experience provided for the collectors. Imagine the wealth of personal growth accruing to the pupils of a teacher who wishes to exploit the possibilities of a class project of collecting science materials. Of course, the class would plan its collection carefully, drawing on as many sources of suggestions as possible. A committee of pupils might undertake this exploration, consulting science texts, experienced teachers, high-school science laboratories, or existing literature on the subject of elementary-school science materials.

The group could be provided with a small budget, either earned or donated. Student committees would then shop for "best buys," both in person and thru correspondence. Funds would have to be properly budgeted, and when money was spent, receipts would have to be secured and accurate financial records maintained.

Other student committees might secure items from attics, junk yards, and similar repositories of discarded odds and ends. Of course, much material could be constructed and improvised by pupils.

As the collection takes shape, pupils can develop facilities for display and storage of tools, equipment, materials, and specimens. Children, individually or in groups, could assume responsibility for keeping materials in good supply and in good order.

OTHER VALUES IN MAKING LOCAL COLLECTIONS

The procedure suggested above is rich with possibilities for desirable learning experiences. Purposeful planning, democratic group action, seeking and using information, delegating and accepting responsibility, carrying on flesh-and-blood correspondence, budgeting of real money, seeking of best purchase values, keeping genuine records, practice of manual skills, developing resourcefulness and ingenuity, caring for "community" property—all these and many other wholesome activities can be a part of the experiences of youngsters whose teacher stimulates a project of local collection of elementary-school science materials. Indeed, the potential of this learning experience far outweighs the intrinsic value of the items in the collection.

Of course, this procedure requires effort. Much time and energy of pupils is involved, as is thought and guidance on the part of the classroom teacher. But the students' time and energy result in desirable learnings, and the teacher's thought and guidance are directed along the lines of his mission—enhancing the education of children.

PROBLEMS OF UNDERTAKING LOCAL COLLECTIONS

Teacher-pupil groups that do undertake a local collection of concrete materials for elementary-school science are faced with some pressing problems. The next few pages are devoted to a discussion of four of these. For brevity, they might be expressed as follows:

1. What shall we acquire?
2. Where shall we get it?
3. What could we build—and how?
4. How can we store science materials?

What Equipment Is Desirable?

One of the first questions confronting teachers who wish to undertake local collections of science materials is, "What shall we acquire?" Obviously, this is strictly a local problem, and teachers and pupils must find their answers in terms of their own needs and resources. Even so, there are many places to turn for help. The publications listed below, for example, all provide lists of equipment:

Blough, Glenn E., and Blackwood, Paul E. *Science Teaching in Rural and Small Town Schools.* U. S. Office of Education, Federal Security Agency, Bulletin 1949, No. 5. Washington, D. C.: Superintendent of Documents, Government Printing Office, 1949. 55 p.

Blough, Glenn E., and Blackwood, Paul E. *Teaching Elementary Science.* U. S. Office of Education, Federal Security Agency, Bulletin 1948, No. 4. Washington, D. C.: Superintendent of Documents, Government Printing Office, 1948. 40 p.

Coogan, Irene. "Elementary Science Program." *Science Teacher* 13: 81-82; April 1946.

Cox, Louis T. "Home Made Equipment in Teaching General Science." *Science Teacher* 15: 69, 95-96, April; 124, 138-39, October 1948.

Feeney, Elizabeth F. "Elementary Science Laboratory." *Teachers College Record* 49: 393-97; March 1948.

Hubler, Clark. "Suggested List of Science Supplies." *Science Teacher* 19: 115-17; April 1952.

Hubler, Clark. *Science Materials for Elementary Schools.* Doctor's thesis. New York: Teachers College, Columbia University, 1949. (Typewritten)

Maddux, Grace. "Problem of Supplies for Elementary Science; How One Large City Solves the Problem." *Science Teacher* 19: 114-15; April 1952.

Piltz, Albert. "Science Laboratory for the Elementary School." *Science Teacher* 18: 190-92; October 1951.

From these and other sources, a "shopping list" has been prepared specifically for the teacher who, while not a specialist in science, is nevertheless anxious to undertake a local collection of elementary-school science materials. This suggested "want list," complete with its own introductory remarks, will be found at the end of this article.

Where Can Materials Be Obtained?

Another problem which the local collector faces is, "Where can we acquire these materials?" A surprising variety of suitable materials can be obtained from nearby hardware stores, toy shops, drug stores, variety stores, grocery stores, and garden shops. Pharmacists can and usually will supply certain specialized materials such as test tubes, rubber stoppers, simple chemicals, and glass and rubber tubing. A few unusual but highly desirable items such as strong magnets and iron filings can be obtained from science supply houses. These establishments are to be found in many large cities.

There are many less obvious sources of science equipment readily available to the average classroom. Among these are toys brought from the children's homes. Construction toys such as "Tinker Toy" or "Erector" sets can be of tremendous value. So can skates, wagons, scooters, and similar "rolling stock," and likewise the more advanced toys such as electric trains, microscope kits, toy kitchen devices, and chemical sets. These are "borrowable" without cost, and proud is the youngster who is invited to bring his prized possessions for classroom use. It is not necessary to elaborate on the highly motivated situations which this practice creates.

This procedure of borrowing materials from homes need not be

confined to toys. Household appliances, tools, mechanical gadgets, and kitchen utensils all are potentially valuable. Nor is the home the only source of such aids. Equally productive are the automobile, the school custodian's quarters, the industrial arts shop, the physical education storeroom, most any boy's pockets, and most any teacher's purse!

What Equipment Can Be Constructed?

It has already been urged that teachers and pupils combine their efforts to construct certain elementary-school science equipment. Not only does this practice provide the needed materials at negligible cost, but it affords the builders priceless experience in construction skills and in individual and group planning. Classroom teachers need not rule out such activities because of their own lack of skill in manual arts. Many practical construction projects in science involve nothing more advanced than dextrous use of scissors and paste, paper and string, pencil and paint, thumbtacks and Scotch tape.

Even projects involving simple wood-working need not impede the unskilled teacher. Many schools have obtained small, simple wood-working benches. Older boys or custodians can make these from nails and soft wood. If there are only one or two such tables in a school, they can be moved from room to room as needed. The list below suggests tools for such a unit, roughly in order of their need:

Pliers, with cutters
Screwdriver, medium size
Knife—not folding
Hammer
Saw—crosscut, 24″ long
Small bench vise
Can opener—rotary type
Tin snips
File—single cut, flat, 10″ long
Coping saw, with spare blades
Sandpaper, assorted
Hacksaw, with spare blades
Plane, small size
Paint brushes, assorted

Equally simple are the materials involved in most elementary-school construction projects. This list is suggestive only:

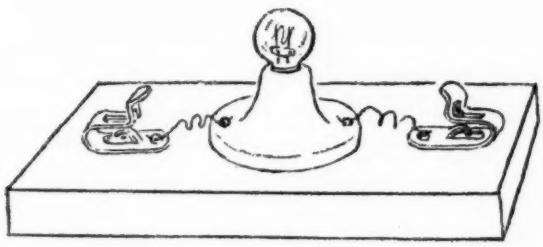
Wood, from crates and cigar boxes
Nails, assorted
Cardboard and paper
Iron wire, such as stovepipe wire
Heavier iron wire, as from coathangers
Screws, nuts, and bolts, assorted sizes
Tin cans
Water-base paints

There are many sources of ideas and instructions for useful things to build. Many of the resources listed on pages 268 to 270 include some such ideas. Teachers and pupils will often wish to modify such plans, or to develop their own "from scratch." Construction need not be confined to models and demonstrations per se; some such projects may be aimed at the production of useful teaching devices. One such project, suitable as a class activity, concerns a set of equipment which has proved highly effective in helping youngsters learn

about simple electric circuits. It is included here as an illustrative example.

Teachers who attempt to assemble simple electric circuits for their classes find themselves confronted with constant "nuisance" properties of electric components and wire. Insulation is sometimes difficult to remove, sometimes difficult to keep in place. Connecting wires often kink; frequently they fray at the ends. Connections to circuit components are usually made unnecessarily difficult by the need for tools, or by the presence of small screws. Typical binding posts are usually difficult for little fingers to manipulate and, in any event, the parts are subject to accidental loss. Manipulations of electric circuits for instructional purposes can be streamlined by assembling a set of specially prepared parts and wires, as described herewith.

Individual electric components can be mounted on individual wood plaques, as illustrated below. These plaques may be cut from soft



wood (for example, the ends of fruit crates) and might be 4 to 6 inches on a side. Components can be secured to these bases with screws. Electrical connections to each component are provided by Fahnestock clips, usually two for each component. These handy spring clips permit the ends of wires to be inserted without tools of any kind. The plaques may be colored for attractiveness and for easy reference.

Connections between components are most easily made with *solid* (i.e., not stranded) wire. This may be No. 18, No. 20, or No. 22 in size. This wire must be insulated. Insulation should *not* be of enamel, which must be carefully scraped off at the ends, and it should *not* be of twisted cotton wrapping, which is tedious to unwind and results in uneven ends. Two acceptable kinds of insulation are:

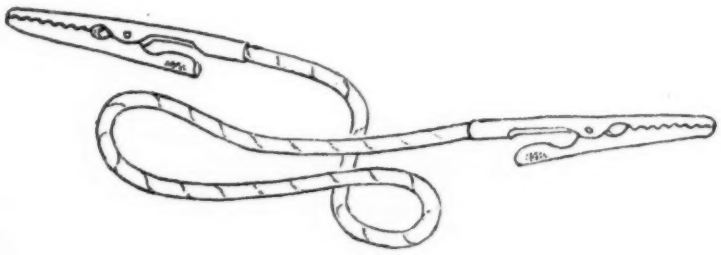
Plastic—easily skinned off with knife or scissors and does not fray
"Push-back"—woven fabric, easily slipped back from the ends with the fingers, and does not fray

These desirable kinds of bell wire or hookup wire can be obtained at hardware stores or at radio supply houses.

Among the electrical components found most useful for children are:

Item	*Source*
Miniature screw-base porcelain lamp socket (flashlight size)	Hardware store
Miniature screw-base lamps—low voltage (1.5 volts, 2.5 volts, 6 volts, etc.)	Hardware store or radio supply house
Porcelain-base knife switches	Hardware store
Door-bell type push button	Hardware store
Porcelain-base toggle switch	Hardware store
Telegraph key	Homemade or from radio supply house
Toy electric motor	Homemade or from toy store
Buzzer or door bell	Hardware store
Telegraph sounder	Homemade
Electromagnet	Homemade
1.5 volt dry cells (can be purchased equipped with Fahnestock clips)	Hardware store or radio supply house

It is also convenient to have a small supply of easy-to-use connecting wires with handy spring clips at either end. These can be readily made with rubber-coated flexible test-lead wire and alligator clips as illustrated below. These supplies also can be obtained from radio supply houses.



Many supplies for this and related types of activities can be obtained from mail-order radio supply houses, of which there are many thruout the nation. Typically, these organizations sell at "net" prices to all individuals and institutions, bar none. While the bulk of their business is transacted with professional radio-servicemen and with radio "hams," they offer many items of interest to people in general and to classroom teachers in particular. Among these are radios of all kinds, television sets and accessories, phonographs, tape and wire recording equipment, table lamps (fluorescent), public address systems and accessories, and hand tools.

The following figures, taken from the catalog of one large wholesale radio supply house, are illustrative of general price levels of specific items:

Item	*Price*
Fahnestock clips—1″	10 for 8¢
Rubber-coated flexible test-lead wire	3¢ per foot
Alligator clips with screw connections (no solder required)	10 for 54¢
No. 20 solid hook-up wire, plastic coated	25 feet for 32¢
Miniature screw-base lamps (price listed is for 2.5 volts)	11¢ each
Miniature buzzer—high pitched tone—operates on 3 volts	$1.18 each
Double-cotton covered No. 22 magnet wire (½-pound spool contains 234 feet—ideal for homemade electromagnets and homemade electric motors)	91¢ for ½-pound spool
No. 6 dry cells (1.5 volts each; without Fahnestock clips)	58¢ each

Once the components are mounted on plaques, and connecting wires (either with plain ends or with alligator clips) are on hand, teachers and pupils will use them frequently. Even in primary grades, for example, these units can be useful in setting up a door-bell circuit for the playhouse, or a lamp for the doll house. It should be noted that the voltage of dry cells is so low that it cannot be felt, much less be dangerous. In typical elementary-school use, dry cells will give service for a year or more before having to be replaced.

How May Materials Be Stored?

The problem of storing and displaying science materials in the elementary school is not a great one. Surely, teachers and pupils who have the initiative and courage to undertake a local collection of such equipment are resourceful enough to improvise a way of keeping it in good order, yet available for use. One highly practical suggestion is to use a typical household chest of drawers—perhaps one obtained from an interested parent. One drawer might be used for "stock" such as wood, nails, wire, and paper, while another could be used for tools. The remaining space would then be available for specimens, equipment, models, and all the other concrete materials which are on hand. The top surface could be used either for display purposes or as a demonstration stand. A coat of paint makes this "science department" serviceable and attractive.

Some teachers have devised combination storage-demonstration units mounted on wheels for mobility. The top surface is 36 to 40 inches

above the floor, and is specifically designed for demonstration space. It is usually water repellent. Some de luxe models are even equipped with a sink which drains into a bucket placed on a lower shelf or on the floor. Lower parts of the unit may be devoted to shelves, drawers, doors, and hooks for the storage of other materials.

These suggestions, coupled with the woodworking bench mentioned on page 262, should give the ambitious and imaginative teacher some ideas for the solution of storage-display-demonstration problems in elementary-school science.

FINDING IDEAS FOR ACTIVITIES

Many classroom teachers feel that their lack of experience in science will prevent them from making good use of concrete teaching materials such as those discussed on these pages. They fear that they cannot find useful activities even when the equipment is available. This fear, too, is unfounded. There exists a rich variety of "Things-To-Do," "How-To-Do-It," "Experiments-with-Science" books aimed specifically at the elementary-school level. Many of the most representative of these have been assembled into a resource list reproduced on pages 268 to 270.

In general, these resources stress the physical sciences. This is true largely because the physical sciences are by nature better suited to simple, short experiments and demonstrations. For example, the teacher can show the behavior of a magnet much more quickly and directly than he can show the behavior of a bean seedling. This is not meant to imply that experimentation in life science is less important than experimentation in the physical sciences. And it is true that writers of elementary-school science books should turn more attention to this neglected field.

Many teachers are unnecessarily confused about the grade placement of learning experiences in science. It would appear that the writers of elementary science activity books have ignored this issue. Actually, many elementary-school science educators agree that learning experiences in science properly defy specific grade placement. Thus, a given experience may be suitable for third-grade comprehension, but if seventh-grade children have never known this experience, it may be wise to provide it for them. Again, the mental ability and the science background of youngsters in a given classroom usually have a tremendous range, making strict grade placement of science experiences not only impractical but unnecessary and undesirable. In practice, teachers who know children can adapt a given experience to almost any desired grade level, merely by adjusting

the approach, the pace, the vocabulary, and the degree of thoroness employed. The writer has seen the same demonstration-experiment performed twice on the same day—once to juniors in college and once to primary-grade children. It was difficult to tell which group was the more interested.

The list of science-experience references [2] on the following pages includes some materials written for teachers, some written for students. Collectively, they cover the entire age range from kindergarten thru junior high school. Some of the instructions are adequate; some are not. Some experiences, as might be expected, are imperfect in other ways. But each of these resources is worthy of inspection—all can be of help to the enterprising teacher.

[2] This list is intended to be suggestive rather than complete. These resources are intentionally confined to those which provide suggestions for *things-to-do*. The list, therefore, omits the tremendous variety of descriptive literature in the field of elementary-school science. Furthermore, children's textbooks and textbooklets are omitted, as are periodical publications in such categories as college, popular, commercial, professional, and government sources. Likewise omitted are the publications of state, county, and city school offices, and free and inexpensive materials issued by industrial and business organizations.

Much elementary-school science can be learned thru experiences involving common items found around home and school.

Public Schools, Baltimore, Maryland

REPRESENTATIVE RESOURCES FOR ELEMENTARY-SCHOOL SCIENCE EXPERIENCES

Arey, Charles K. *Science Experiences for Elementary Schools.* Practical Suggestions for Teaching, No. 4. New York: Teachers College, Columbia University, 1942. 98 p.

Baer, Marian E. *Experiments Without Fire.* New York: Rinehart and Co., 1947. 114 p.

Baer, Marian E. *Sound, An Experiment Book.* New York: Holiday House, 1952. 127 p.

Beeler, Nelson F., and Branley, Franklyn M. *Experiments in Science.* New York: Thomas Y. Crowell Co., 1947. 116 p.

Beeler, Nelson F., and Branley, Franklyn M. *Experiments with Electricity.* New York: Thomas Y. Crowell Co., 1949. 145 p.

Beeler, Nelson F., and Branley, Franklyn M. *More Experiments in Science.* New York: Thomas Y. Crowell Co., 1950. 176 p.

Blough, Glenn O., and Huggett, Albert J. *Elementary School Science and How To Teach It.* New York: Dryden Press, 1951. 532 p.

Blough, Glenn O., and Huggett, Albert J. *Methods and Activities in Elementary School Science.* New York: Dryden Press. 1951. 310 p.

Bruce, Guy V. *Science Teaching Today.* Washington, D. C.: National Science Teachers Association, a department of the National Education Association. Seven volumes, including:

Vol. 1. *Experiments with Water.* 1950. 48 p. 75¢.
Vol. 2. *Experiments with Air.* 1950. 44 p. 75¢.
Vol. 3. *Experiences with Fuels and Fire.* 1950. 31 p. 75¢.
Vol. 4. *Experiences with Heat.* 1950. 40 p. 75¢.
Vol. 5. *Experiences with Magnetism and Electricity.* 1951. 72 p. 75¢.
Vol. 6. *Experiences with Sound.* 1951. 44 p. 75¢.
Vol. 7. *Experiences with Light and Color.* 1951. 47 p. 75¢.

Cormack, Maribelle. *First Book of Stones.* New York: Franklin Watts, 1950. 93 p.

Craig, Gerald S. *Science for the Elementary-School Teacher.* Boston: Ginn and Co., 1940. 551 p.

Croxton, Walter C. *Science in the Elementary School.* New York: McGraw-Hill Book Co., 1937. 454 p.

Freeman, Ira M. *Invitation To Experiment.* New York: E. P. Dutton and Co., 1940. 238 p.

Freeman, Mae, and Freeman, Ira M. *Fun with Chemistry.* New York: Random House, 1944. 58 p.

Freeman, Mae, and Freeman, Ira M. *Fun with Science.* New York: Random House, 1943. 60 p.

Garrison, Charlotte G. *Science Experiences for Little Children.* New York: Charles Scribner's Sons, 1939. 111 p.

Gordon, Bertha F. *Prove It Yourself.* Dansville, N. Y.: F. A. Owen Publishing Co., 1929. 255 p.

Greenlee, Julian. *Teaching Science to Children.* Dubuque, Iowa: William C. Brown Co., 1951. 57 p.

Horning, John L., and McGinnis, G. C. *Open Door to Chemistry.* New York: Appleton-Century-Crofts, 1946. 86 p.

Hudspeth, Jack, and Hudspeth, Frances H. *Handbook for Teachers of Elementary Science.* Austin, Texas: Steck Co., 1938. 76 p.

Keelor, Katherine L. *Working with Electricity.* New York: Macmillan Co., 1935. 111 p.

Lord, Eugene H. *Experimenting at Home with the Wonders of Science.* New York: D. Appleton-Century Co., 1940. 243 p.

Lynde, Carleton J. *Science Experiences with Home Equipment.* Second edition. Scranton, Pa.: International Textbook Co., 1949. 230 p.

Lynde, Carleton J. *Science Experiences with Inexpensive Equipment.* Second edition. Scranton, Pa.: International Textbook Co., 1950. 266 p.

Lynde, Carleton J. *Science Experiences with Ten-Cent Store Equipment.* Second edition. Scranton, Pa.: International Textbook Co., 1950. 262 p.

Meister, Morris. *Magnetism and Electricity.* Living in a World of Science, Bk. 3. New York: Charles Scribner's Sons, 1929. 210 p.

Morgan, Alfred P. *An Aquarium Book for Boys and Girls.* New York: Charles Scribner's Sons, 1936. 180 p.

Morgan, Alfred P. *Boy Electrician.* Revised edition. New York: Lothrop, Lee, and Shepard Co., 1948. 407 p.

Morgan, Alfred P. *Boy's Book of Engines, Motors, and Turbines.* New York: Charles Scribner's Sons, 1946. 264 p.

Morgan, Alfred P. *Boy's Book of Science and Construction.* Revised edition. New York: Lothrop, Lee, and Shepard Co., 1948. 465 p.

Morgan, Alfred P. *First Chemistry Book for Boys and Girls.* New York: Charles Scribner's Sons, 1950. 179 p.

Morgan, Alfred P. *Getting Acquainted with Chemistry.* New York: D. Appleton-Century Co., 1942. 271 p.

Morgan, Alfred P. *Simple Chemical Experiments.* New York: D. Appleton-Century Co., 1942. 269 p.

Morgan, Alfred P. *Things a Boy Can Do with Chemistry.* New York: D. Appleton-Century Co., 1940. 288 p.

Morgan, Alfred P. *Things a Boy Can Do with Electricity.* New York: Charles Scribner's Sons, 1938. 243 p.

National Education Association, National Commission on Safety Education and National Science Teachers Association. *Safety Through Elementary Science.* Washington, D. C.: the Commission, 1949. 39 p. 50¢.

Parker, Bertha M. *Science Experiences, Elementary School.* New York: Row, Peterson and Co., 1952. 272 p.

Partridge, James A. *Natural Science Through the Seasons.* Toronto: Macmillan Co., 1946. 520 p.

Popular Science Monthly. *Astronomy for Amateurs.* New York: Grosset and Dunlap, 1934. 192 p.

Schneider, Herman. *Everyday Machines and How They Work.* New York: McGraw-Hill Book Co., 1950. 192 p.

Schneider, Herman. *Everyday Weather and How It Works.* New York: McGraw-Hill Book Co., 1951. 189 p.

Schneider, Herman, and Schneider, Nina. *Let's Look Inside Your House.* New York: William R. Scott, 1948. 39 p.

Schneider, Herman, and Schneider, Nina. *Now Try This.* New York: William R. Scott, 1947. 40 p.

Schneider, Nina, and Schneider, Herman. *Let's Find Out.* New York: William R. Scott, 1946. 38 p.

Selsam, Millicent E. *Play with Plants.* New York: William Morrow and Co., 1949. 62 p.
Selsam, Millicent E. *Play with Trees.* New York: William Morrow and Co., 1950. 64 p.
Selsam, Millicent E. *Play with Vines.* New York: William Morrow and Co., 1951. 63 p.
Spilhaus, Athelstan F. *Weathercraft.* New York: Viking Press, 1951. 64 p.
Swezey, Kenneth M. *After Dinner Science.* New York: McGraw-Hill Book Co., 1948. 182 p.
Wells, Harrington. *Elementary Science Education in American Public Schools.* New York: McGraw-Hill Book Co., 1951. 333 p.
Yates, Raymond F. *A Boy and a Battery.* New York: Harper and Bros., 1942. 120 p.
Yates, Raymond F. *Boys' Book of Magnetism.* New York: Harper and Bros., 1942. 166 p.
Zim, Herbert S., and Cooper, Elizabeth K. *Minerals; Their Identification, Uses, and How To Collect Them.* New York: Harcourt Brace and Co., 1943. 368 p.

TEACHING SCIENCE WITHOUT A SCIENCE BACKGROUND

Fortunate indeed is the elementary-school teacher who is surrounded with teaching materials and equipment, who has tools and supplies for simple construction activities, and who has an adequate shelf of science experience books. But many teachers, even tho they might be so ideally situated, dread the thought of selecting and guiding meaningful experiences in science. They fear that their own lack of science background will be painfully obvious, that many pupils will know more than they do, that they will be clumsy with relatively unfamiliar equipment, that they will be asked too many questions to which they have no answers, that they will be mortified beyond measure when "the experiment doesn't work." This article would be incomplete if these timid teachers were not given reassurance and encouragement.

It must be remembered that elementary-school teachers are not expected to know all about science, any more than they are expected to know all about literature, or mathematics, or history. After all, the proper specialty of such teachers is not subjectmatter, but *children.* Furthermore, the body of science is so vast that no one—not even the professional scientist—knows more than a thin veneer within his own specialty and a few scattered fragments here and there among other branches of science.

It is altogether proper, then, for the elementary-school teacher to answer a question with, "I don't know." And it is courageous and pedagogically sound to add, "Does anybody know?" or, "Perhaps we can work together and find out." Indeed, often the wise teacher

who *does* happen to know uses replies similar to the latter two. This attitude encourages problem-solving situations of a most natural and compelling character. And it provides opportunities for group planning, finding answers to questions, and developing original ideas. In this way, pupils and teacher working together add to their supply of information. And it must be remembered that there is an impressive body of evidence to indicate that youngsters particularly enjoy their learning when they realize that their teacher is learning something too.

But perhaps the most important feature of such a situation is that pupils and teacher alike are participating in firsthand, purposeful, functional problem solving—they are exploring, finding, and using information, investigating things thru observation and experiment, and having a chance to employ scientific attitudes. Thus they ar making progress not only in specific knowledge, but they are "learning how to find out." And this, according to most science educators' opinions, is in the highest echelon of the objectives of elementary-school science education.

SUGGESTED SUPPLIES—A "WANT LIST"

One of the outstanding characteristics of science is that problems and issues are approached from an experimental point of view. This should also be true of science education. It is a serious error to confine pupils' sources of information to the phrases of the book and the words of the teacher. Where practicable, inquiries should be met with challenges such as "Let's find out" and "Why don't you try it and see?"

It is virtually impossible to carry on this investigational approach to science education without a supply of equipment and materials. No teacher can expect to have—or needs to have—a complete laboratory in which to teach elementary-school science. Indeed, much of the most valuable science-experience equipment that teachers can use is to be found in the classroom, in the home, in the school storeroom, and in boys' pockets. Frequently it can be borrowed and brought to school for the duration of its need.

But these materials are not enough. In addition, teachers should have available a well-selected supply of simple, concrete materials on which they can draw when the need arises. The list of suggested equipment on these pages, while incomplete, is more than a list of minimum requirements. Rather, it is a list of items which have been found highly useful in elementary-school teaching. As such, it is a list from which teachers can select items they may wish to acquire.

THINGS MECHANICAL

- Bathroom scales
- Beam balance, calibrated in pounds and ounces and fractions of ounces—5 to 10 pounds capacity is sufficient
- Spring balances, calibrated in pounds and ounces—in a variety of sizes
- Single pulleys, 1½″ in diameter
- Double pulleys, 1½″ in diameter
- Sashcord or stout clothesline
- Hand-operated pressure pump, such as bicycle pump or athletic equipment pump

THINGS ELECTRICAL

- Radio hookup wire—solid pushback, or bell wire, plastic covered, No. 18, 20, or 22
- Dry cells, No. 6 size
- Screw-base sockets for miniature lamps—flashlight size
- Screw-base miniature lamps—1½ volts, 2½ volts, 6 volts
- Copper strip, 1″ x 4″
- Zinc strip, 1″ x 4″
- Electric door bell or buzzer—low voltage operation
- Porcelain knife switches
- Door-bell type pushbutton switches
- Electric extension cord

THINGS MAGNETIC

- Pair bar magnets, 3″ to 6″ long
- Horseshoe magnet, good quality
- Fine iron filings stored in saltcellar
- Magnetic compass
- Assorted steel sewing needles and steel knitting needles
- Assorted large nails (spikes)

THINGS CHEMICAL

- Litmus paper, red and blue
- Slaked lime
- Table salt
- Ammonia
- Carbon tetrachloride
- Hydrochloric acid, 10 percent solution
- Sulfuric acid, 10 percent solution
- Vinegar
- Copper sulfate crystals
- Paraffin
- Baking soda
- Table sugar
- Tincture of iodine (for starch test)
- Benedict's solution (for sugar test)

GLASS AND RUBBER WARE, AND SUPPORTS

- Pyrex test tubes, ¾″ x 6″
- Test tube rack
- Test tube brush
- Conical flask, 500 cc
- Pyrex beakers, 100, 250, 500, and 1000 cc
- Soft-glass tubing, 6 millimeter diameter
- Rubber tubing (to fit 6 millimeter glass tubing)
- Medicine droppers
- Forceps—e.g., baby-bottle tongs
- Metal or plastic funnel, 3″ to 5″ in diameter
- Filter paper or paper towels
- Ring stands
- Burette clamps
- Ring clamps, 3″ and 5″
- Right angle clamps
- Iron rod, ½″ diameter, 12″ to 24″ long
- Rubber stoppers — solid, one-hole, and two-hole in sizes as follows:
  - No. 1 (fits soft-drink bottle)
  - No. 2 (fits ¾″ test tube)
  - No. 7 (fits 500 cc conical flask)
  - No. 8 (fits milk bottle)

LIGHT AND SOUND

- Convex lenses—focal length: 5 cm., 15 cm., 25 cm.
- Magnifying glass
- Colored cellophane or gelatin
- Focusing flashlight
- Assorted mirrors

Triangular glass prism, 3″ long
Lantern slide cover glasses, 3¼″ x 4″
Lantern slide ground glasses, 3¼″ x 4″
100 watt bulb with socket and lead cord
Blueprint paper and/or Ozalid paper
Tuning fork (middle C or A)
Harmonica
Toy musical instruments
Bells, common
Gamut bells

HEAT AND TEMPERATURE

Fahrenheit thermometer, 0 to 230 degrees
Candles
Alcohol lamps and fuel alcohol (wood alcohol)
Canned heat
Wire gauze (screen), 6″ square
Iron tripod, 4″ to 5″ in diameter, 6″ high
Electric hotplate, small
Safety matches

PLANTS AND ANIMALS

Animal cages
Insect cages
White rats, hamsters, or similar animals
Aquarium, fish, and aquatic plants
Assorted flower pots
Assorted plants, seeds, bulbs
Fertile soil and sand
Soil fertilizer, including nutrient chemical mixtures
Plant press

TOOLS

Pliers, with cutters
Screwdriver, medium size
Knife, not folding
Can opener, rotary
Tin snips
File—single cut, flat, 10″ long
Coping saw, with spare blades
Sandpaper, assorted
Hacksaw, with spare blades
Plane, small
Hammer
Saw—crosscut, 24″ long
Small bench vise
Paint brushes, assorted
Glass cutter
Diagonal cutting pliers, 6″ long
Brace and a few common size bits
Rotary drill and a few common size carbon steel twist drills

FIRST AID

Tannic acid gauze
Band-Aids
Merthiolate
Absorbent cotton
Sterile gauze
Adhesive tape
Rubbing alcohol
Sterile applicators

MISCELLANEOUS

Soda straws
Pyrex cooking utensils
Teaspoons, tablespoons, knives
Aluminum cooking pans
Thread, string
Scotch tape
Scissors
Steel wool
Moth balls
Ping-pong balls
Paper clips
Water base paints, assorted
Assorted wood (fruit crates, cigar boxes, etc.)
Assorted tin cans
Rubber bands
Straight pins
Thumb tacks
Modeling clay
Yardstick, rulers, tapeline
Large-mouth glass jar
Milk bottles
Soft-drink bottles
Assorted small bottles
Quick-drying cement
Glue
Library paste, paper cement
Iron wire
Assorted nails
Assorted screws, nuts, and bolts

Handling Science Equipment

By TRACY H. ASHLEY, JR.

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THE teaching of elementary-school science does not require expensive or elaborate equipment. The experiments most frequently done by children are simple, and the equipment needed, therefore, is also simple. Much of the material used can be homemade or purchased in the local five-and-ten, drug, or hardware store. There are areas of science, however, for which it is necessary to buy some commercial apparatus in order that our children be insured rich and meaningful experiences.

In these days of bulging school buildings and strained school budgets it is often difficult to find the money or the storage space for needed science equipment. It is ideal, but impracticable, for each classroom to have on hand at all times the equipment necessary to conduct all experiments. Yet science equipment should be available to all teachers when needed.

COMMERCIAL KITS—ONLY A PARTIAL SOLUTION

The kits that may be purchased from several of the supply houses are only a partial solution to the problem. In many cases the teacher will take the whole kit to the classroom instead of the few pieces of equipment necessary to conduct experiments in the area of classroom interest. These kits are also rather expensive and the same amount of money will purchase a greater quantity of loose equipment from a supply house. If all orders for science equipment for a school are pooled, it will facilitate handling and allow the school to take advantage of discounts. This will also preclude duplication of equipment.

There is the problem then of supplying science equipment and storing it in a place where it will be available to all teachers. This problem is not as difficult as it might seem to teachers; it has been solved in a number of ways.

HOMEMADE WOODEN BOXES

One solution is to have the children build a number of wooden boxes. Each box contains the equipment necessary to do the experiments in a certain area of science. All boxes have labels printed by

the children reading "Magnetism," "Electricity," "Sound," and "Light." Altho the boxes do not have to be elaborate, the children may want to paint them. The boys and girls have many good learning experiences in the construction of the boxes, such as measuring, building, printing, and painting.

These boxes can be made of plywood, pine, or even from the wood of orange crates. A good size for easy storage is 18" by 22" by 4". The size, of course, can be varied to fit shelving or floor space. These boxes will take up little space piled one on top of another on the floor or stored in a closet. If a school is large and can afford more science equipment, the boxes and equipment can be duplicated for the more popular areas of science. Teachers sign out for the boxes and cross their names off when materials are returned.

SAMPLE BOXES

Following is a list of suggested equipment for various subject areas. This list is not meant to be complete, nor is it necessary to include every item in each box to conduct experiments in these areas.

MAGNETISM

Lodestone
Horseshoe magnet (large)
U magnets (alnico, small)
Bar magnets
Magnet holder
Magnetic needle
Magnetic compass
Iron filings
Knitting needles
Pieces of glass
Pieces of scrap metal (iron, copper, aluminum, etc.)
Nails, paper clips, tacks

ELECTRICITY

Flashlight
Dry cells
Miniature sockets
Miniature lamps
Insulated copper wire
Soft iron bolts
Silk cloth
Cat skin or fur
Pith balls
Electric bell, D. C.
Electric buzzer, D. C.
Push button switch
Knife switch
Friction rod, glass
Friction rod, rubber
Rubber balloons
Tin foil
Fuse plugs

LIGHT AND SOUND

Flashlight
Mirror
Concave lens
Convex lens
Reading glass
Glass prism
Candles
Meter stick
Color wheel
Pin-hole camera
Old box camera
Length of rubber hose
Megaphone
Water glasses (8)
Tuning forks
Music wire
Rubber bands
Fork

HEAT

- Hot plate
- Alcohol lamp
- Compound bar
- Ball and ring apparatus
- Nursing bottle
- Balloons
- Bars of different metals (to show conductivity)
- Thermometer
- Thermostat model

AIR AND WEATHER

- Model wind vane (can be made)
- Model anemometer (can be made)
- Convection box (can be made)
- 3 lbs. of mercury
- Barometer tube, well, and pipette
- Aneroid barometer
- Psychrometer (can be made by mounting 2 thermometers on a board)
- Outdoor thermometer
- Nursing bottle
- Balloon
- Milk bottle

MACHINES

- Single pulleys
- Double pulleys
- Hand balance
- Roller skate
- Rubber bands
- Doll rods
- Model windmill (can make)
- Model screw jack
- Model seesaw (can make)
- Inclined plane (can make)
- Model steam engine
- Model gasoline engine
- Model electric motor
- Model water mill (can make)

OTHER BOXES

This list is meant to include only the equipment which could be used in the units of work in elementary-school science mentioned. By no means would this be considered a complete list of materials necessary to conduct an elementary-school science program.

Other boxes could be constructed and labeled "Miscellaneous." These might contain such items as glassware, corks, seeds and bulbs, chemicals, rubber and glass tubing, tin cans, wire, and tools. Aquariums and terrariums, cages, cold frames, and other large items could be kept in the classroom.

If the viewpoint is taken that many everyday experiences of children have important implications for science, then it becomes clear that science should be taught to a large extent with materials which are found in the children's own environment.

—*Science Education in American Schools*, Forty-Sixth Yearbook, Part I, National Society for the Study of Education.

The Science Corner—
A "Must" in Every Classroom

By ROSS L. NEAGLEY
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OVER a period of years the self-contained classroom has steadily gained favor among classroom teachers and school administrators. Plans for functional school buildings are taking into account the need for various interest centers within each classroom. One of the most popular and important of these is the science corner. This article deals with what inservice teachers have said and written in college classes about this important topic.

FROM ORANGE CRATES TO ELABORATE TABLES

The science corner may vary greatly from room to room and from school to school. In some rooms the lowly orange crate with a few materials on display and some odds and ends of equipment constitute the science corner; in others a vacant desk serves the purpose; while the more elaborate science centers include a large table for experiments, storage space for equipment, bookshelves, and a bulletin board. It is very important that the classroom have a science center regardless of how simple it may be at first. The mere designation of a location for science experiences places emphasis on the importance of science and encourages pupils to bring in materials and equipment. A more elaborate and functional center may then be developed thru cooperative pupil-teacher planning.

PLANNING A SCIENCE CORNER

The planning of a science corner can be a valuable experience for children. Group discussion concerning the best location for it in the classroom, actual work in rearranging the room, and bringing in equipment and materials for the corner give children many opportunities to work together and to assume responsibilities.

In describing the planning of her science corner a third-grade teacher in the Edgely School, Bristol Township, Pennsylvania, writes:

> In our room we are rather limited for space. We had one large table which had been used mostly as a work table. This we pushed against the wall and put chairs around the remaining three sides. On the back of the table against the wall we stood all our science books and other

reference books. On one end of the table we keep our wild life exhibits and on the other end our displays and equipment for experiments. On the wall behind the table we have pictures which pertain to the particular subject being studied. Leading questions are posted on the bulletin board. On the shelf above the table we keep equipment that we do not have room for on the table. Projects are also kept there.

A teacher in the Cleveland School in Philadelphia describes the beginning of his science corner as follows:

First, we found it necessary to select a corner of the room that received adequate sunlight for our plants and animals. Second, we had to secure a long table. Third, we had to convert some unused bookcases into a circulating science library. Finally, we found it advantageous to construct additional bulletin-board space for our science corner.

Another classroom teacher describes the science corner in his room as a movable one. He feels there is value in changing its location from time to time.

THE CENTER IS A POPULAR PLACE

The science corner is usually the most popular center in the classroom. Because children help to plan it, they consider it their own. The ever changing array of materials and equipment arouses interest and stimulates curiosity. Children from other classrooms are attracted to the center during the lunch and play periods.

A primary teacher in the H. R. Edmunds School in Philadelphia says:

I never really appreciated what the science corner meant to the children until they were dismantling the room for Christmas vacation. One child remarked, "We won't take apart our science corner. That will still be here in 1952 to greet us. We don't have to touch that do we, Miss Brown?" The children were greatly relieved to know that the science corner would remain.

The children like their science corner for the following reasons:

1. It is their interest spot.
2. It is filled with things that are constantly changing.
3. It contains things they can handle, feel, touch, squeeze, lift, examine, smell, see, and manipulate.
4. The children are the curators.
5. It is a miniature laboratory.
6. It encourages the children to explore.
7. It arouses interest at home and parents send in materials.
8. It is built by children and centers around their natural interests.
9. It offers a place for them to experiment during their free time.

One teacher observed that more pupils are attracted to the science corner when the items displayed are changed frequently. He also

found that an attractively painted sign placed above the science table helps to attract pupils, particularly if the wording is in question form. Another teacher writes: "The first thing that attracted my attention was the many children from other rooms who same to see our corner."

THE CENTER AS A MOTIVATING FORCE

A teacher in the Webster School in Philadelphia feels the science corner has kindled interests and stimulated scientific thinking in her classroom this term. She suggests that placing something on the table with no explanation at all often arouses curiosity, which can lead into a new unit of work. She believes the science corner has been particularly helpful because it involves touching, arranging, operating, taking apart, observing, and talking about science materials.

Sometimes the teacher may wish to stimulate interest in a specific area by placing certain materials in the science corner. One teacher relates that she placed a homemade water wheel on the science table two days before she planned to start a new unit. The first day only one pupil questioned her about it. The second day a number of pupils became interested and wondered about its use. This produced the necessary motivation to begin the unit.

CONTRIBUTIONS TO GROWTH IN GOOD CITIZENSHIP

The science corner not only satisfies individual interests, it also contributes to good group living. Pupils get together in groups around the table, exchange ideas, manipulate equipment, and find tentative answers to their questions.

A classroom teacher in the Gilbert School in Philadelphia describes how a new boy in her room improved in adjustment as a result of the science corner. The boy was transferred to her room with an unfavorable record in behavior and studies. Shortly after entering her class he began to show an interest in the science corner. He brought to school many articles for the center and frequently reported to the class concerning things he had read. Due to his interest in science, he showed considerable improvement both in work habits and in behavior.

This teacher also believes the science corner in her room has helped the children improve their attitudes toward one another. Her pupils have learned to work together more effectively in both small and large groups, and they have learned to share ideas, thoughts, and materials.

Another teacher in the Ferguson School in Philadelphia also agrees that the science corner contributes to improved citizenship. In de-

scribing his science corner he mentions the fact that one of his pupils who used to be a disciplinary problem now goes to the science table when he completes his required work instead of annoying those around him. This boy became one of the heaviest contributors to the science corner. He even spent some of his own money to buy fish and fish food.

A number of teachers reported that committees assumed responsibility for the science corner. The following duties of one such committee were reported from the Kearney School in Philadelphia:

1. Keep bulletin boards attractively arranged and up to date
2. Keep science work table straightened up and supplied with the necessary equipment
3. Keep class record of all experiments, projects, and research reports
4. Act as librarian for the science library
5. Act as a special research group for the class whenever the need arises
6. Give out all equipment and see that it is returned
7. Keep all science equipment cleaned and in its proper place.

CONTRIBUTIONS TO LANGUAGE ARTS PROGRAM

Pupils who bring in materials for display on the science table or articles and pictures for the bulletin board will want to tell the class about them. It will be necessary to make labels for the materials on display and to provide attractive titles for the articles and pictures on the bulletin board. As a result of the stimulus of these materials, articles, pictures, and experiments, pupils will want to do research in order that they may verify their tentative conclusions and learn more about the science concepts they are acquiring.

AN INTERESTING AND ATTRACTIVE PLACE

In summary, it is hoped that the reader will be convinced that a science corner can contribute a great deal to the program in every classroom. A convenient and prominent place in the room should be chosen so that the children will have easy access to it. If enough room is available, the center should contain a table, storage space for equipment, bookshelves, and a bulletin board.

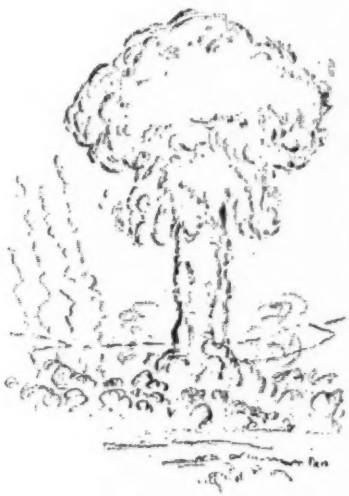
The science corner should be an interesting, active place. It should be characterized by variety, practicality, and usefulness. The center should be a "living" one, not a museum or dust collector. It must be arranged attractively so that children do not become confused by a hodgepodge of materials. On the other extreme, it must not be vacant or empty looking or the children will not be challenged.

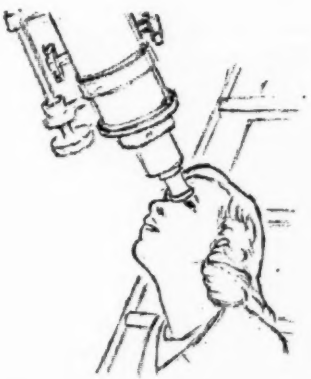
A science corner is a "must" in every elementary-school classroom. Whether it be called "Science Center," or "Science Corner," whether it be simple or elaborate, no room should be without one.

CHAPTER TEN

Looking into the Future

No one knows for certain what the future holds for science or for science education, but barring worldwide disaster the year 2000 will certainly be as different to the child of today as the year 1950 was to the child of 1900. The tempo at which the curtain of the unknown is being pushed back seems to increase geometrically with each passing decade. In this last chapter Dr. Fletcher G. Watson, a scientist and science educator at Harvard University, looks into the future and tries to visualize what the world of science has in store for mankind. Paralleling this article, Dr. Gerald S. Craig, the well-known science educator at Teachers College, Columbia University, plots a course for elementary-school science in the years that lie ahead. Together the two articles provide a fitting conclusion for this Thirty-Second Yearbook of the Department of Elementary School Principals.





Science from Now to 2000 AD

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LET'S dream a bit about the developments in science and about their probable impact upon society between now and the year 2000 AD. Surely no reader will expect a rigorous and detailed forecast of what will come in the next 50 years. The history of science since 1900 clearly indicates the impossibility of finding in our mental crystal ball the major developments that may occur during a half century. However, the very nature of these difficulties, arising from the peculiar characteristics of the scientific enterprise, may be worthy of examination. Three levels of scientific development must be considered: the *unexpected*, the *possible*, and the *probable*.

UNEXPECTED DEVELOPMENTS

The *unexpected* developments will probably be the most important ones. They arise as a result of novel observations or points of view occurring to someone deeply immersed in a particular inquiry. Sometimes they are expedited by the development of a new type of instrument which allows a whole field of study to be explored and exploited. Instrumentation and ideas often go so closely together that frequently it is difficult for us to say which is the chicken and which is the egg. Perhaps we would agree that any list of major unexpected developments in science during the past 50 years would include the following five:

1. The interpretation of atomic spectra has resulted both in the quantum theory of energy and in very complex mathematical models for the behavior and structure of various types of atoms.

2. Perhaps the most astounding discovery of the past 50 years was that of nuclear fission. This was utterly unexpected even to the group of scientists employing neutron bombardment as a new tool to provide information about atomic structure. Hahn and Strassmann, who in 1938 first saw that certain of their experimental results would make sense only if the uranium atoms were actually splitting into two large components, were themselves exceedingly loath to propose seriously such a fantastic and completely unexpected interpretation.

3. The isolation and eventual large-scale manufacture of numerous antibiotics from soil bacteria and molds were not anticipated. As early as the 1870's Louis Pasteur had asked himself what became of all the obnoxious bacteria that went into the soil and seemed to disappear there; but

in his busy life he had no opportunity to follow up this provocative question. Nearly 50 years were to pass before Fleming and then Florey noted the behavior of penicillin molds which Waksman followed with the study of soil bacteria and the isolation of many antibiotics.

4. In the last 50 years our whole idea about the size and structure of our universe has expanded at such a rate that all of us are dizzy. In 1900 the universe was a relatively small and relatively simple system—because of our great ignorance. Now it is complex, scattered, in rapid motion internally, and not well explained. Here we find an example of the truism that often the more information we have about an area the more difficult it is to propose satisfactory descriptions.

5. The surprising discovery that radio waves are received from invisible astronomical objects has only in the last few years opened another field of study with its own complexity and concurrent confusion.

POSSIBLE DEVELOPMENTS

The area of the *possible* involves the imaginative extension of studies and results just barely glimpsed at the present time. During the past 50 years developments of this sort have resulted from the application of biochemical studies to the design and manufacture of a host of synthetics. Our economy, strongly based on the utilization of oil, natural gas, and their derivatives, illustrates this potentiality.

In the past 50 years radio and wireless communication devices became a reality and then commonplace, with such novel developments as radar and television following in their wake. The field of theoretical genetics, just 50 years old, has developed so fast that already international economic and political affairs of the first magnitude have been influenced by the abundant production of designed hybrid corn. Scientific study of nutrition and all it means to insuring the continued health of the human race has come from laboratory studies which 50 years ago were little known, exceedingly modest, and "obviously impractical." Aviation and aeronautics, with their enormous impact upon the way of life both in the civilian and military sense, were hardly more than a hope 50 years ago when the pioneers were flying kites.

PROBABLE DEVELOPMENTS

The third area, the *probable*, is easy to discuss because it involves an extension of familiar types of things and operations. It means we shall have more and better materials and ideas similar to those currently available. Perhaps our best illustration here from history would be the development and fantastic applications of the internal combustion engine, with all that it has meant to society for good or evil. The area of the probable is more likely to be represented by the technological development of earlier scientific ideas and information. Society's selection of possible technological developments is based either upon

military necessity or upon anticipated economic returns on investments. Many things that may be done are not necessarily desirable or practical economically.

Sociological Concerns

Sociologically, the scientific developments of the past 50 years have brought two major concerns to our society. In the realm of ideas there has been a great loosening and shaking of the stability that existed thru the Victorian period. The self-confidence was epitomized in the 1890's in a statement by a distinguished British physicist who said, in effect, that all the things of physics were then known—there was nothing new to be learned and henceforth the physicist would be concerned only with increasing the accuracy of the measurements already performed. The blindness of this position, and the difficulty of forecasting the future, are clearly illustrated here because just at that time the very initial experimentations in the fields of X-ray, radioactivity, photoelectric effects, relativity, and atomic interpretation were being carried out with crude equipment in obscure laboratories. Intellectually, the first half of the twentieth century has presented our society with quite a different picture of man's so-called mastery of the universe. The philosophical questions resulting from the theory of evolution, knowledge in genetics, and the control of the physical environment are very severe and continually with us.

Along with the philosophical implications of the scientific developments has come thru technology another form of social concern—technological unemployment. When society has supported an accelerated expansion and variation in the types of goods and services provided, many old types of operations and equipment have become obsolete. The individuals trained and capable of performing these operations have found themselves released to the labor market and have been obliged to change or perish. No longer is it possible for us to train an individual for a particular routine job and expect that thruout the remainder of his life little or no changes will be demanded of him. Education for the future must be for flexibility and anticipated change rather than for stability.

Predictions of specific scientific results likely to occur during the next 50 years can be made only with fear and trembling. Undoubtedly, novel and unexpected scientific discoveries of phenomena and their descriptions will burst upon us. These unpredictables are likely to be the really important things to occur in science, for they open up whole new lines of possibilities for exploration, thought, and potential social application.

Public Schools, Baltimore, Maryland

Children should be made to feel that science belongs to everyone.

What may develop from possibilities now glimpsed is still quite fuzzy. Probably our ideas about the nature and function of a virus will be appreciably clarified with revolutionary ideas about the nature of the life process. Certainly the continued exploitation of medical and biochemical studies will tend to prolong life even more and sharpen our social problems. Already the greatly extended life span in the United States, the addition within half a century of 20 years to the mean life expectancy, has had an enormous social impact. More people live longer, yet retire from productive employment earlier. These people must be fed, housed, and clothed even tho their incomes from savings are often quite modest. The concurrent rise of a nationwide program of social security has been a direct consequence. Large numbers of elderly unemployed people constitute a political bloc which will grow rapidly during the coming decades. Further

medical success in the prevention and amelioration of the diseases of advanced age will probably extend the lifetime of the elderly. Thus society and perhaps educators must be concerned with the possibility of encouraging these individuals to undertake some satisfying efforts; otherwise, they are merely put on the shelf to live out their lives and die. The worldwide productivity of food for a growing population, some millions of which still die of starvation every year, will require nationwide and worldwide cooperative concern and action.

Transportation

In the area of transportation almost surely rocket travel both over the earth and probably into the nearer parts of the solar system will become a reality. One must look with some skepticism upon the vaunted claims currently made that establishment of a space satellite circling a thousand miles or more above the earth will make future war impossible. Nobel, the inventor of dynamite, believed almost a hundred years ago that this explosive was so powerful that war could never occur again. History, alas, illustrates that Nobel did not appreciate adequately the stubborn stupidity of the human race for the aggrandizement of mass destruction. One must suspect that the elimination of warfare will not result from any technological advances—space satellites, hydrogen bombs, bacterial warfare, or the like—but only from a change of attitude toward international affairs which will no longer consider mass murder as an adequate solution to diplomatic and social problems.

Technological Unemployment

In the technological fields the introduction of more and more automatically controlled machinery may accelerate technological unemployment. Furthermore, such unemployment will be drastic, for a whole type of employment may be erased by the introduction of a machine. It may not be merely the blacksmith changing into the auto mechanic, but perhaps finding that even the whole line of trade or skill will have evaporated.

Communications

In communications the equipment will become more compact and efficient as a result of the use of transistors which are replacing many of the radio tubes, themselves a marvelous development of the last 50 years. A ray of hope appears that individual person-to-person radios, as visualized by "Dick Tracy" and others, may be impractical. Of course, such devices will be technically possible, but the wide-scale

use of them so that any individual is continually exposed to harassment by any other individual in the society seems highly improbable; fortunately the radio spectrum and therefore the number of possible transmitters is limited.

Automatic printing is nearly a reality; other electronic filing and sorting systems appear in dreams and may materialize. Such devices will permit any one individual to have rapid access to greater stores of information. What use is made of the information depends upon how the controlling individuals have been educated.

Conservation

Finally, we shall be increasingly concerned with watching the availability of natural resources. Our society is consuming natural resources, both materials and energy, at such a rate that now the identification of stockpiles of iron ore or of oil that will last for 20 to 50 years is considered a major achievement. While it is often asserted that the scientists will always come up with some substitute for a resource running in short supply, this seems a naive assumption and fails to recognize that the removal of one resource requires the substitution of another.

New Sources of Energy

Whether nuclear fission will provide an economically practical source of energy, probably in the form of electricity, cannot be foretold. Certainly within a few years the controlled production of energy on a large scale from nuclear fission will be demonstrated, but it may not be economically practical. Within 50 years it seems more probable that the direct harnessing of sunlight, either thru enormous solar reflectors or thru the stimulated growth of green water plants, will be more important than nuclear fission. In sunshine we have the one continuous source of energy, while the other sources—uranium, wood, oil, and even coal—are expendable and not renewable within a reasonable period. Hydroelectric power may be expanded somewhat, but probably not more than 10-fold over that now available.

EDUCATIONAL PRACTICES MUST CHANGE

Looking forward toward 2000 AD we can only hypothesize that fundamental changes will occur in scientific knowledge and in concurrent technological possibilities. Any firmer predictions are necessarily "more of the same" that we have now. But the clear implication is that many of our educational practices tied to the past are already obsolete and that education for the twenty-first century must be markedly different from that currently offered.

Index to the Future

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TO APPRAISE science in the education of children, we need to take a realistic view of the elementary school. An understanding of this institution, its purpose, and the factors in society operating to influence it are necessary to an intelligent development of elementary-school science. In addition, it is imperative that we give attention to newly discovered knowledge and technics in the development of curriculum materials. These considerations are necessary in determining the goals of instruction in science in elementary education.

The elementary school is an institution of pressures. There are many groups in our society that are anxious to have the attention of boys and girls. These groups, many of them with desirable goals, clamor for a place in the elementary-school program.

Because of pressures exerted by our society upon the elementary school, a new category does not gain acceptance quickly. Many proposed categories have not succeeded in becoming established as a permanent part of the curriculum in spite of well financed publicity. Pressures of different kinds will come and go, but only those areas which can be satisfactorily supported in terms of the purpose and nature of the elementary school will become accepted as a part of the curriculum on a national basis. It is most necessary that the purpose of the American elementary school be considered in the development of elementary-school science.

ROLE OF THE ELEMENTARY SCHOOL

The American elementary school is a unique institution. It has been called at times "the great common school," in that it is the school for all the people. It was established by our forefathers as the one institution that would be common to everyone, regardless of race, religion, and economic status. This was the basic institution dedicated to the education of people for citizenship in a democracy. Therefore, any category such as science, entering into the curriculum of the elementary school, must be developed in the interests of all boys and girls.

Science in childhood education should be an area which is fundamental for children living in a democracy. It should be freed from the

paraphernalia of specialized science. In all our thinking we must make certain that we are considering how science fits into a program of elementary education in a democracy and not how children fit into a program of science. Perhaps we should describe science as a part of the program of childhood education rather than thinking of science as a separate program.

The elementary school has in its enrolment not only the future scientists of our country, but the laymen as well (and everyone is a layman outside his own field of specialization). The task of science instruction is a much larger one than discovering children of exceptional ability in science and starting them on their way to becoming scientists. Primarily, the task involves education for all pupils for their own and society's benefit and only secondarily involves concern for the welfare or future of science.

THE DEVELOPMENTAL POINT OF VIEW

Science in childhood education should be considered completely from a developmental point of view that is sound with regard to the fundamental nature of both children and science. This basis seems to be interpretation of the environment. Thru science, mankind has attempted thru the centuries to interpret his universe. The individual, too, attempts from birth to death to orient himself to the forces of his environment. This indicates that the historic function of science—that of explanation or interpretation of the events of the environment—is in keeping with the dynamic drives of children. Teaching and learning in the field of science can be consistent, then, with the nature of children.

From the developmental point of view of science education, children do not come to school for the first time at zero in science learning. They have already reacted to gravity, energy, lightning, thunder, darkness, light, weather, and a host of other scientific phenomena. They may bring with them misconceptions and superstitions, and become a liability to society, or they may come to school with a good attitude for learning and ready for the development of resourceful behavior. The fact that a child lives in a universe which causes him to interact with it and that he is surrounded by others with interpretations which they force upon him causes him to form interpretations, correct and incorrect, in the preschool years.

Science learning as defined in this article begins in the cradle. As a child begins to separate himself from his environment, he begins to develop experiential learnings. In a real sense the parent may be thought of as the child's first teacher of science. School systems will do well to invite parents to cooperate in science education.

Science instruction in the elementary school should be considered from the dynamic point of view of child psychology. Children are active. They attempt to secure adjustment and equilibrium in a dynamic universe. They use the senses of smelling, tasting, feeling, seeing, hearing, kinesthetic senses, imagination, curiosity, energy, irritability, restlessness, play, response to external conditions, and other only partly understood drives deep within their natures to project themselves into the areas of their environment thru impulse, fancy, and creative activities just as their ancestors did for thousands of years. These drives are the biological inheritance they have secured from the past of the human race.

These are good drives. They can lead to investigation, creativeness, and inventiveness. If properly developed with the values of our social heritage of democracy, these drives can give children the resourcefulness needed by a nation and world in developing the future.

CLASSROOM TEACHERS AND SCIENCE

It should be borne in mind that the success that science has had in the elementary school is to no small extent the result of the work of classroom teachers. They have experimented with new activities, new content, and new methods. Many of them have constructed curriculum materials and developed reading material in science. The interest with which children take hold of science delights many teachers and, according to their testimony, has paid large dividends in the cooperative attitude secured from the children, not only toward science but toward other school activities.

In looking to the future, it is most important that science be maintained as a possible program for classroom teachers. Specialists in subjectmatter and other fields are prone to make excessive demands upon classroom teachers. Such requirements as expecting teachers to know by name all objects in the environment, animate or inanimate, to be a field naturalist, a laboratory technician, and a general bureau of information are impossible as well as infeasible. Elementary-school science must continue to be structured along realistic lines for both classroom teachers and children. It must be recognized that the classroom teacher has many professional duties; teaching science is but one of the tasks. He is a specialist in the education of children and not necessarily a specialist in science. Any cooperation between classroom teachers and science specialists should be on the basis that both are specialists.

Elementary-school science must not be high-school science brought down to the elementary-school level. Traditional demonstrations and equipment of high-school or college physics, chemistry, and biology

can provide no adequate basis for instruction in the elementary school. Very few high-school teachers, however well qualified they may be at their own levels, are competent in elementary-school science. The material used in the classroom should be in general the kind of material already familiar to children in their own community.

Science, as a newcomer in the elementary-school curriculum, has created a need for the reconstruction of teacher education. Much progress has been made thru new curriculums in many teachers colleges and schools of education, as well as thru workshops and field centers set up by local school systems. Professional subjectmatter courses in science for classroom teachers have been developed in many teacher-education institutions.

IMPLICATIONS OF THE METHOD OF SCIENCE

While the scientific method, may be considered one of the greatest discoveries of mankind, it should not be imposed upon young children. Anecdotal records indicate children will utilize spontaneously at times all the elements of the scientific method. In attempting to secure explanations and in the solution of problems, the elements of the scientific method can be adapted to the level of children in such a way that they will know what they are doing and why they are doing it, and will have some control over the process.

The scientific method, like other big ideas in science, should be considered from a developmental point of view. Furthermore, it should be kept in mind that the majority of the children will be laymen rather than scientists, and even those becoming scientists will utilize the scientific method only in a very specialized sense within their own field of specialization. Therefore, in keeping with the role of the elementary school in a democracy, we are primarily interested in the scientific method as it applies to behavior in daily living.

It is evident that children do not discover new facts for mankind, but they discover new facts for themselves. It is impossible for children to secure by themselves all the culture they will need for living. Fortunately, they have the assistance of the rich scientific heritage provided for them by the scientists of the past and present.

A VARIETY OF PROCEDURES

The teacher should look to a variety of procedures in teaching science. Discussion, instructional excursions, experiments, reading, and group work and planning all play a part in the teaching-learning situations in science education. It is well for the teacher to be present as a participant in all these procedures. He should be a learner, for good teaching in science involves learning.

If there were one term to be used to specify the kind of instruction appropriate to all phases of teaching science, it would be "developmental." In this case it is developmental from the point of view of children and teachers, both as learners. It means the instruction develops, using the experiences and knowledge children may have or that can be provided for them. It is developmental in that children may participate in the development of the planning for the use of experiences, experiments, discussion, and authentic materials to secure solutions to problems. The new learning is made acceptable to the children by the nature of its development in instruction. The child is given time to internalize new learning, integrating it with his own experiences and ideas.

In modern science we do not view knowledge as absolute. Any statement of science can be challenged, revised, or refuted with suitable data. There is no room for dogmatic attitudes.

The nature of modern science has many profound implications to the content and procedures in the classroom. The primary concern in elementary education is what kinds of boys and girls are being developed. All of us need to be cautious that our procedures do not become mere devices and ends in themselves. The teacher has the duty to play an honest role in the classroom. He has a right to admit that he is learning; that he is mistaken sometimes; that sometimes certain children know more than he does; that sometimes a child with a special interest and concentration may be learning faster than he is. In a real sense, the scientific method is a method of honesty, and neither teacher nor child should be penalized for being honest. The learner should never be humiliated for admission of ignorance. The implications of science to mental hygiene and human relations are profound.

CONTENT OF SCIENCE

The preservation and advancement of our democracy depends to no small extent on the behavior patterns developed in children and youth. We do not know what the future will be. In a sense we must educate children for uncertainty. That does not imply that we need be pessimistic about the problems our children must face. Rather we can be confident that if we assist them to develop intelligent and resourceful behavior, they will make their own future.

It is the contention here that the outlook of children toward their environment and universe is the very core of the development of a resourceful adjustment to the future. While incidents play an important part in making learnings meaningful, science should not be incidental in the lives of children.

Altho we may look to the needs of the individual and of society to determine the setting of science in the elementary school, instruction must not be limited to talking about science. Teaching science should not be confined to a mere description of objects and events. Instruction must involve interpretation of phenomena if children's education is to be sufficient to cope with the problems of today and tomorrow.

We need to give attention to the content as well as to the method in teaching. Changed behavior should result from something more than cautions and commands. It should have a basis of meaningful content. The rich content of science should be directed toward the development of desirable behavior whenever possible.

The large patterns of the universe, such as space, time, energy, change, adaptation, interrelationships, variety, and balance are patterns of growth and development from the cradle thru adulthood. These will never be mastered in our time and perhaps not in a thousand years by scientists, but research indicates children can begin to adjust to the large patterns before they enter kindergarten. Man's success on the planet is dependent upon his ability to cooperate intelligently with the great forces and patterns of the universe. The teacher who is aware of the growth of the large ideas of science can avoid getting the instruction bogged down in small content.

The concept of individuality is a part of the larger pattern of variety. Williams,[1] a biochemist, has recommended that we should start teaching children in the kindergarten that they possess individuality. His recommendation merits the serious consideration of elementary-school workers.

NEW ADVANCES AS SCIENCE CONTENT

One is asked how may elementary-school science keep up with the advances of science. The response to this question depends upon our outlook on science. Thru science man discovers and invents. But discoveries and inventions may be viewed for the curriculum in terms of the age-old drives of mankind and the large patterns of the universe. In this way the events of the contemporary can be better understood as parts of large patterns of development. A single contemporaneous advance may have much identical context with that of the larger patterns. In this way the work can be related from age level to age level. Any consideration of recent advances should be within the scope and purposes of elementary education.

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[1] Williams, Roger J. *Free and Unequal: The Biological Basis of Individual Liberty.* Austin: University of Texas Press, 1953. 177 p.

Atomic energy may be used to illustrate. In this case, we may well see that energy has been a problem of mankind from the earliest days. Man has lived thru revolutionary changes in his social living because of the introduction of new forms of energy and of ways to utilize that energy. The discovery of fire, the introduction of animals to carry man's burdens, the steam engine, the electric generator, and the internal combustion engine greatly changed man's social and economic conditions. The utilization of atomic energy is bringing and will continue to bring tremendous changes. Children should gain a feeling of confidence in the fact that they are not the first of the human race to witness revolutionary changes in energy. Furthermore, it might be well for us to indicate how man's discoveries of new forms of energy and new ways to use energy have brought about a great potential supply of energy for everyone.

New advances in science may be related to the large patterns of the universe. These patterns are more permanent in character than the individual objects of our environment. For instance, incandescent electric bulbs may disappear from our communities, but electricity as a form of energy is likely to be important for many generations. These patterns form basic conceptions for teaching and learning. These, along with the basic drives of science, provide us with the context of science and experience for the inclusion of the new advances of science.

CONSERVATION AS BEHAVIOR

Many of our courses of study help to establish undesirable kinds of behavior. Children are encouraged by many of these publications to develop collections which in turn can rob the environment. They are instructed to bring to school collections of leaves, twigs, flowers, rocks, minerals, and bird nests.

We need to develop in children a feeling of responsibility for the environment. Conservation or intelligent use of natural resources consists of a kind of behavior as well as a body of content. Before moving objects, animate or inanimate, out of the environment and into the classroom, there are many major considerations which the children may discuss. To whom does the object belong? Do I have a right to take it to school? Do I disturb the environment if I remove this object from it? Is the study I am going to make of the object one which merits its removal from the environment? Should I plan to return the object to the environment as soon as the study is completed? Can this object be studied properly if it is removed from the environment? Can I care for it properly in the classroom? If it is alive, does it have a chance to live in the classroom? Am I prepared to give it the

care it needs to survive? One should keep in mind that living things are usually found in an environment to which they are more or less well adapted.

STUDYING CHILDREN

Science in elementary education should be combined with a study of children. The primary concern is not how much information they have. Rather the main emphasis should be on what kinds of boys and girls do we have? What kind of thinking do they do? What are their outlooks upon the world? How the teacher teaches depends upon his knowledge of the children as a group and as individuals.

At all times teachers should be alert to the kinds of behavior found in children. What kinds of attitudes are they developing? Are they dogmatic? Are they gullible? Do they accept opinions without hesitation? Do they look for further evidence before drawing conclusions? Do they draw important conclusions? Do they draw important conclusions without sufficient data? Do they check with authentic information? Do they suggest hypotheses? Are they willing to test their hypotheses? Can they plan and execute plans? Will they consider hypotheses of other individuals? Do they think objectively? Do they give proper credit to others?

It should be kept in mind that it is the behavior in which a child has had some degree of freedom of choices which is the most useful in evaluation. The closely herded or directed question and answer of the quiz program and the rigid recitation have little significance in evaluating behavior. In a sense it is the spontaneous behavior of children—the proposal of something to do, the inquiry, the choice of language in indicating open-mindedness, the critical mindedness, the challenge of a statement, the willingness to consider new ideas and to take on new duties—which is useful in evaluation.

A DYNAMIC EDUCATION FOR CHILDREN

There is a need for a positive and dynamic program for children, one which develops a feeling on the part of children of being needed by our democracy, in times of peace as well as war. Our children are needed not alone for our own nation but for responsibility and work for a better world.

There may be opportunities for children and teacher to work in the improvement of conditions in the classroom, in the school, on the school grounds, and in the community. In this way they can see how science is used.

Science will continue to play an important role in the lives of our children. It is a powerful tool which can be used for good or evil,

and children, the adults of the future, will have to decide how science will be used.

It is most important for the success of our way of life that children have a good feeling toward science. Science should not seem foreign or exotic to them. Science viewed as the result of the age-old drive of mankind to adjust himself to his environment and to maintain his own equilibrium in the welter of biological and physical forces carries with it a larger point of view than a purely vocational one. Science is the result of man's experience and logical thinking thru the centuries. Science, like democracy or the mother tongue, belongs to all who wish to make use of it. Children should be made to feel that science belongs to everyone.

Science instruction should be a pleasant experience for both teachers and children. Teachers should feel relaxed with children while teaching it. Interest in science should be maintained at all levels. The instruction should be freed from busy work and the meaningless drudgery types of assignments. The exhaustive and overly specialized units should be avoided.

Boys and girls must learn to handle and to experiment intelligently with the forces and materials of the universe. Unintelligent tampering and carelessness bring disease, ugliness, waste of natural resources, unemployment, poverty, war, and widespread unhappiness. Children must develop a poised, well-balanced, yet realistic outlook upon the modern world. They must learn that by working resourcefully and intelligently they can create their own world.

The schools of America stand at the threshold of a new era in their history. If they perform their full function, they are to furnish the understandings, the competence, and the will for greatly improved human relationships in our own culture, for more understanding and intelligent relationships with the rest of the world, and for the creative transformation of atomic power into better living. They face a great crisis of opportunity. They may know now with certainty that their critical re-evaluation is in the near offing, that new demands will soon be made of them, and that a new and more complete dependence will be placed upon them.

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